Welcome

—We are glad you are here—

MSUS Agenda 9.12.2016
Basic level and Intermediate Level

	Time	Title	Duration	Moderator
1	8:30- 9:00	Registration		
2	9:00- 9:15	Opening & Welcome	15 minutes	Prof. Safwat Al-Araby
3	9:15- 9:45	Introduction to MSUS examination, Sonoanatomy & Machine setup	30 minutes	Dr. Ahmed Negm
4	9:45- 11:30	Hands on (1) all groups: A1, A2: Basic Level B1, B2: Intermediate Level	95 minutes	Dr. Ahmed Negm Dr. Mohamed Gamal Dr. Abdallah Allam Dr. Ahmed Mosaad
5	11:30- 12:30	Prayer & Break	60 minutes	
6	12:30- 14:20	Hands on (2) all groups: A1, A2: Basic Level B1, B2: Intermediate Level	110 minutes	Dr. Ahmed Negm Dr. Mohamed Gamal Dr. Abdallah Allam Dr. Ahmed Mosaad
7	14:20- 14:30	Closing & Certificate	10 minutes	

Basic level 2 groups: A1, A2
Intermediate Level: B1, B2

WHO WE ARE

MSUS
Physics & Machine Setup

Dr. Ahmed Negm
Lecturer of Rheumatology, PMR
Al Azhar University

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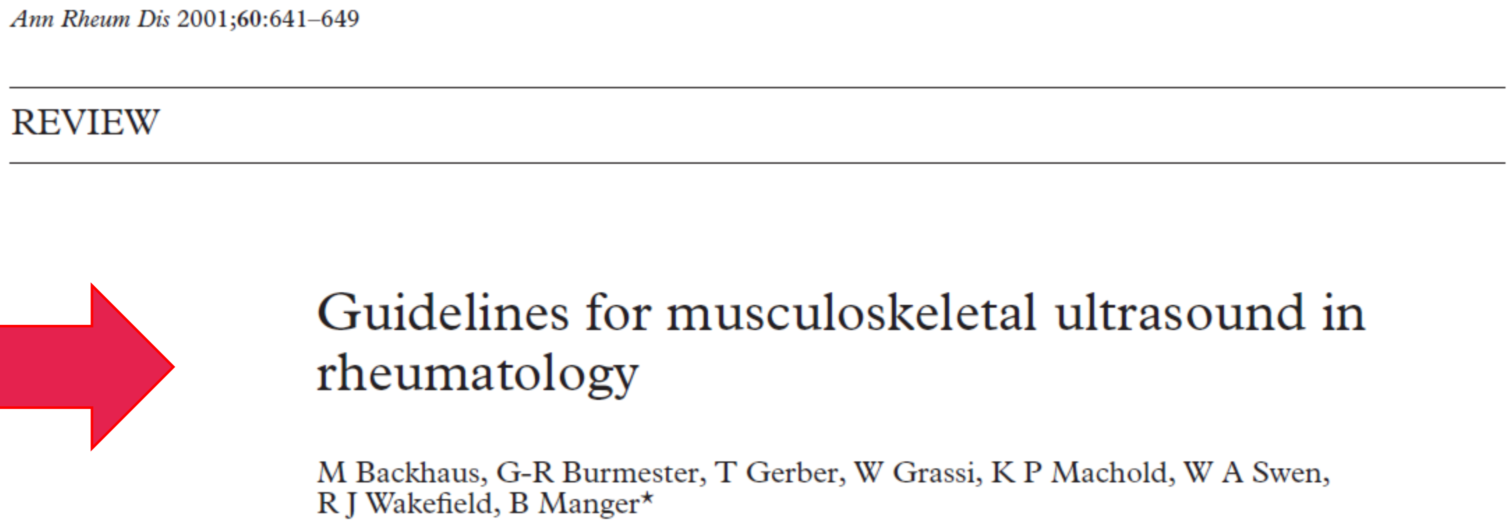
Basics of Musculoskeletal Ultrasound

J. BRYAN DIXON, MD
SPORTS MEDICINE SPECIALIST
MARQUETTE GENERAL HOSPITAL

TARGETED
ULTRASOUND
INITIATIVE

Ihnatsenka B, Boezaart AP. Ultrasound: Basic understanding and learning the language. Int J Shoulder Surg 2010;4:55-62

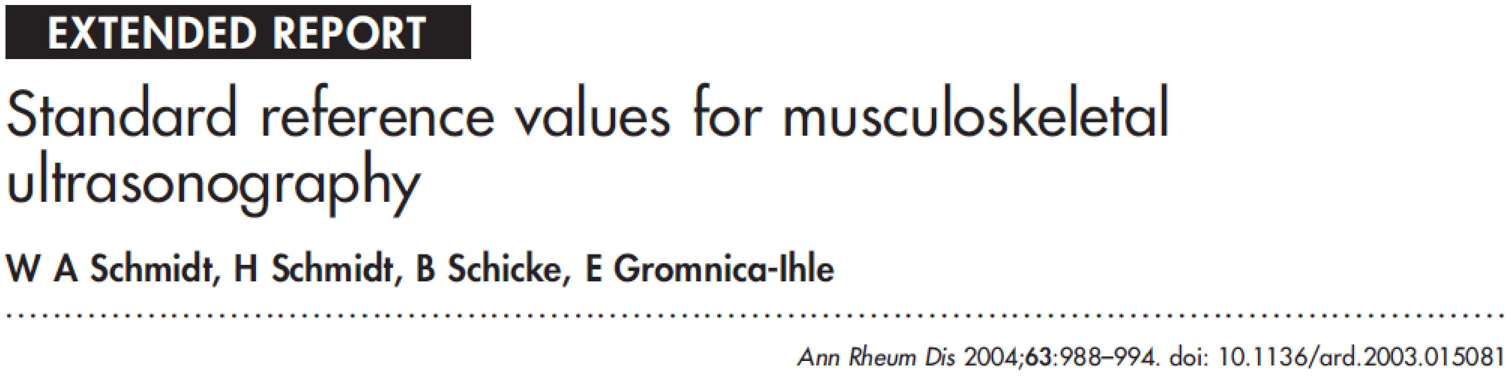


Ann Rheum Dis 2001;**60**:641–649

REVIEW

Guidelines for musculoskeletal ultrasound in rheumatology

M Backhaus, G-R Burmester, T Gerber, W Grassi, K P Machold, W A Swen,
R J Wakefield, B Manger*



EXTENDED REPORT

Standard reference values for musculoskeletal ultrasonography

W A Schmidt, H Schmidt, B Schicke, E Gromnica-Ihle

Ann Rheum Dis 2004;**63**:988–994. doi: 10.1136/ard.2003.015081

OBJECTIVES

- Discuss advantages and indications of diagnostic ultrasound.
- Discuss basic components of ultrasound machine
- Explain concept of ultrasound
- Describe basic physics of diagnostic ultrasound
- Discuss common terminology
- Describe tissue appearances
- Basic introduction to scanning
- Some interesting cases for Intermediate level

Advantages

Dynamic

Low Cost

Minimal technical limitations

Portable

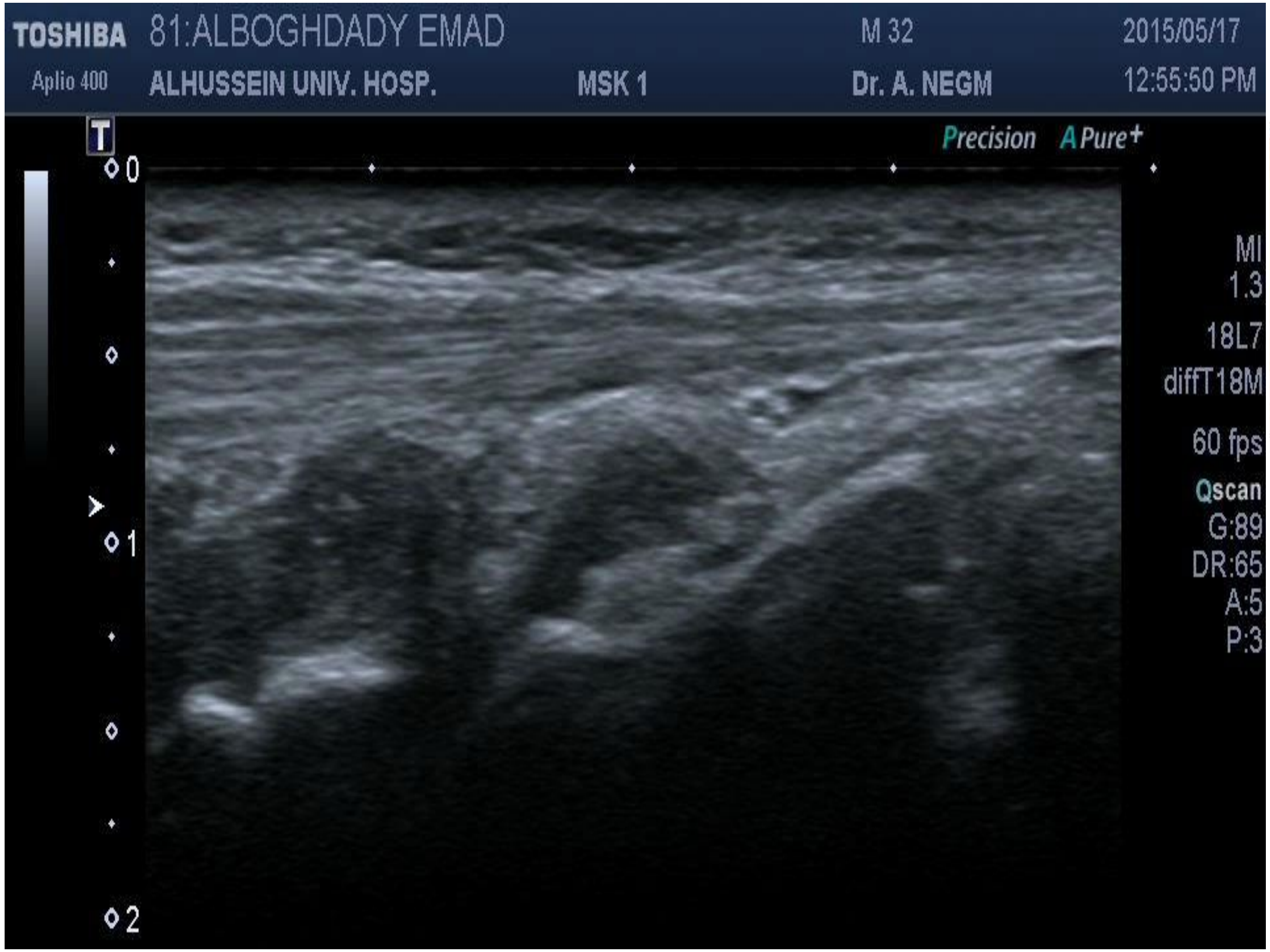
Safe

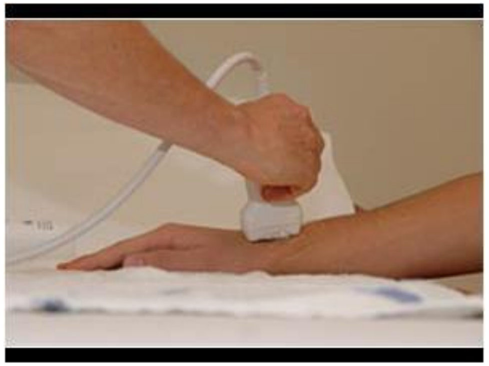
Better resolution MRI

INDICATIONS

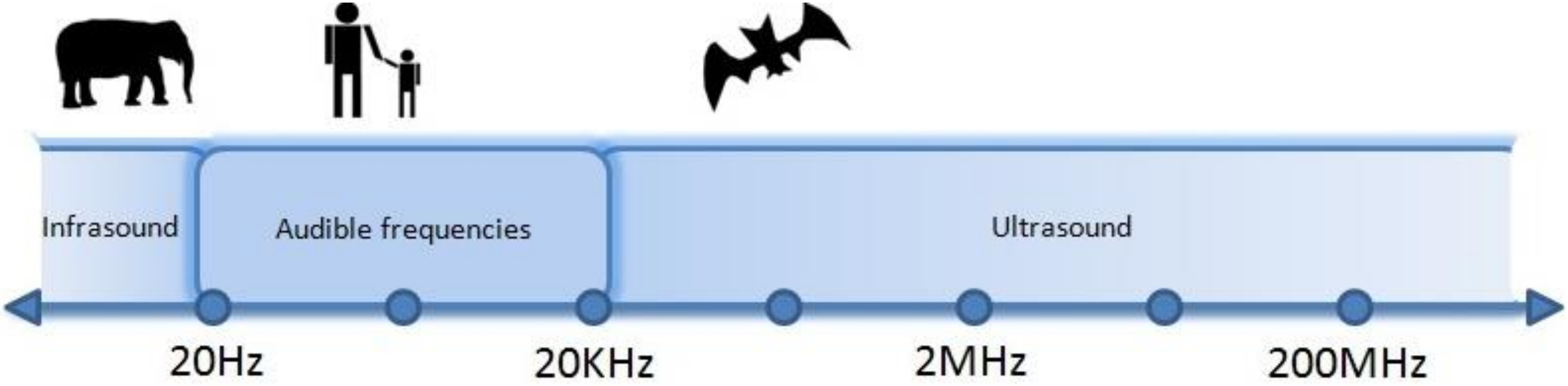
- Detecting pathology
  - Bone- Joints
  - Muscle
  - Tendon
  - Nerve
  - Subcutaneous tissue and bursae
- Detecting foreign bodies
- Locating vascular structures (synovitis, avoid injury to vessels)
- Guiding needle placement for aspiration, injection and biopsy

Elements of MSUS


TOSHIBA
Aplio 400
81:ALBOGHDADY EMAD
ALHUSSEIN UNIV. HOSP.
MSK 1
M 32
Dr. A. NEGM
2015/05/17
12:55:50 PM
Precision
APure+
0
1
2
MI
1.3
18L7
diffT18M
60 fps
Qscan
G:89
DR:65
A:5
P:3

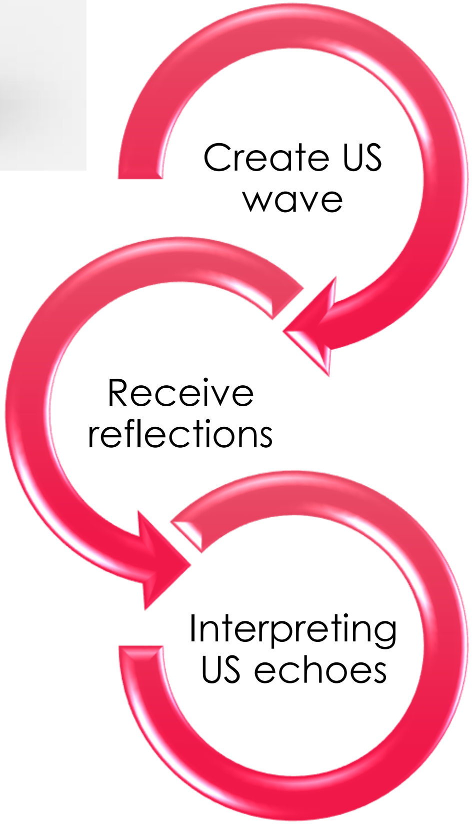


FREQUENCIES



Diagnostic MSUS 7-18 MHz
1 MHz= 1,000,000 Hz
1 Hz = 1 cycle per sec

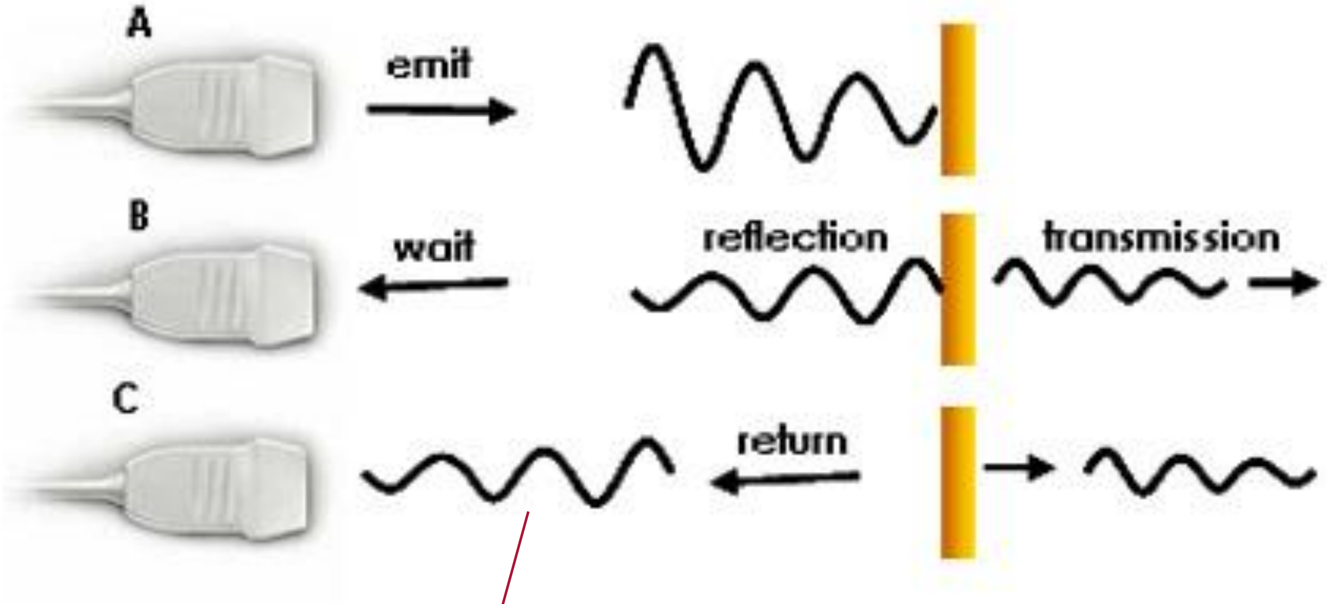
STEPS OF ULTRASOUND IMAGING



Create US wave

Receive reflections

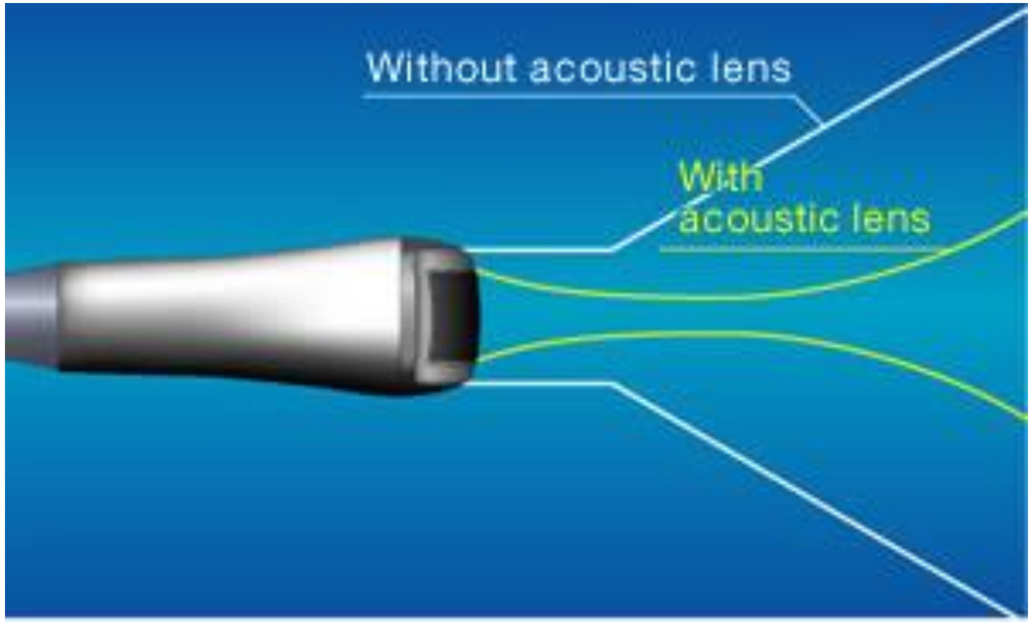
Interpreting US echoes



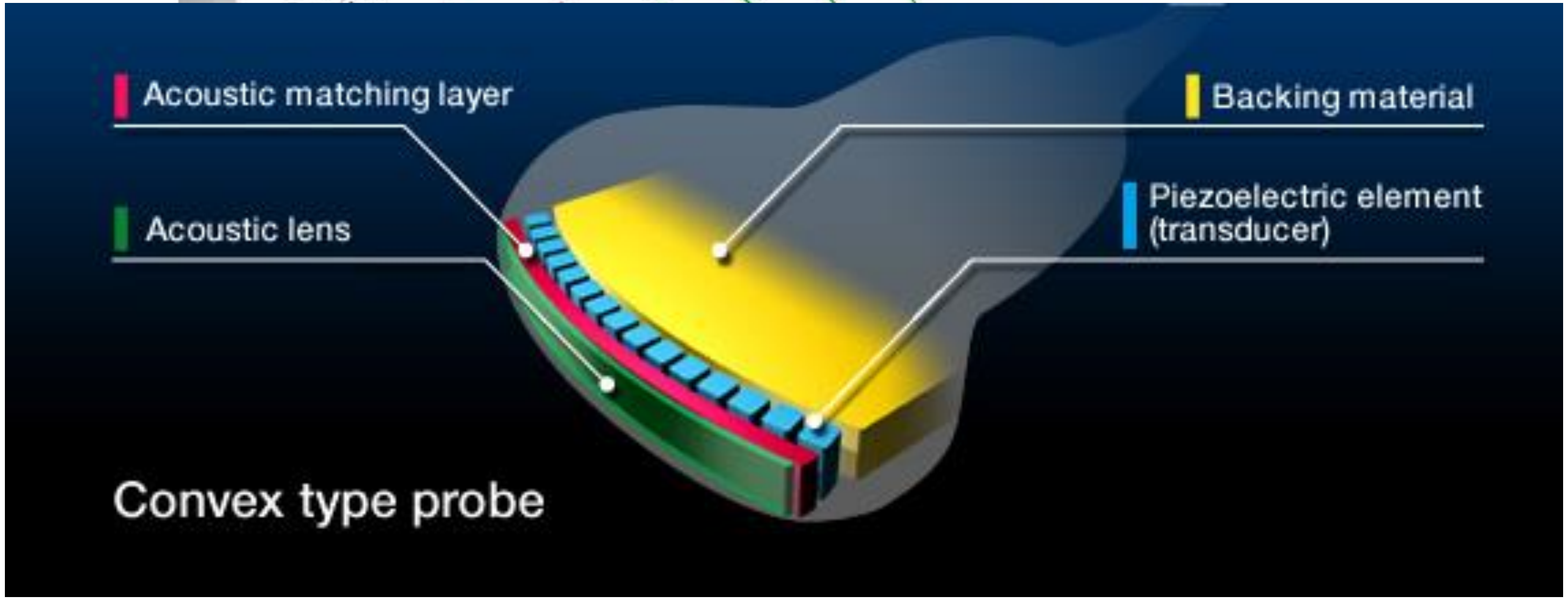
Reflecting echoes are not the same as the original!

Ultrasound is an imaging modality that "creates" images by emitting ultrasound waves.

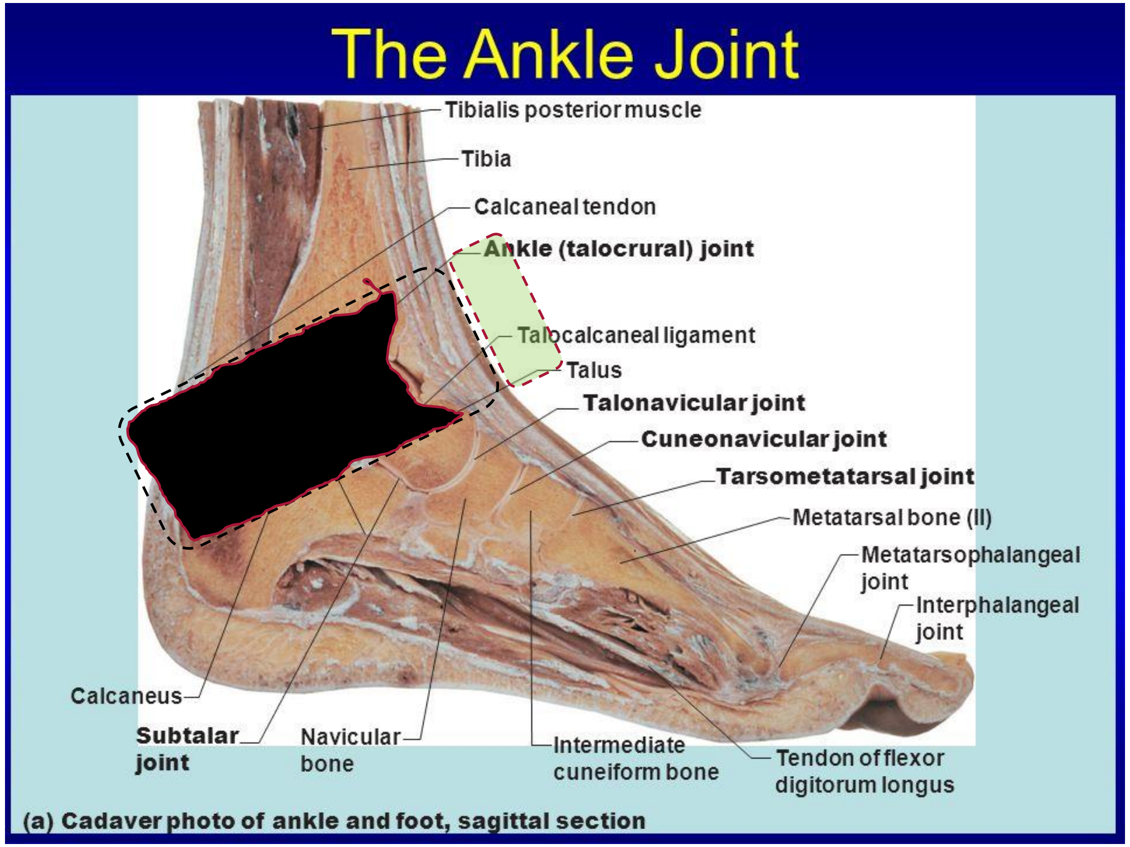
These waves are reflected by the tissue they penetrate and the information of the reflected waves are shown in black and white.



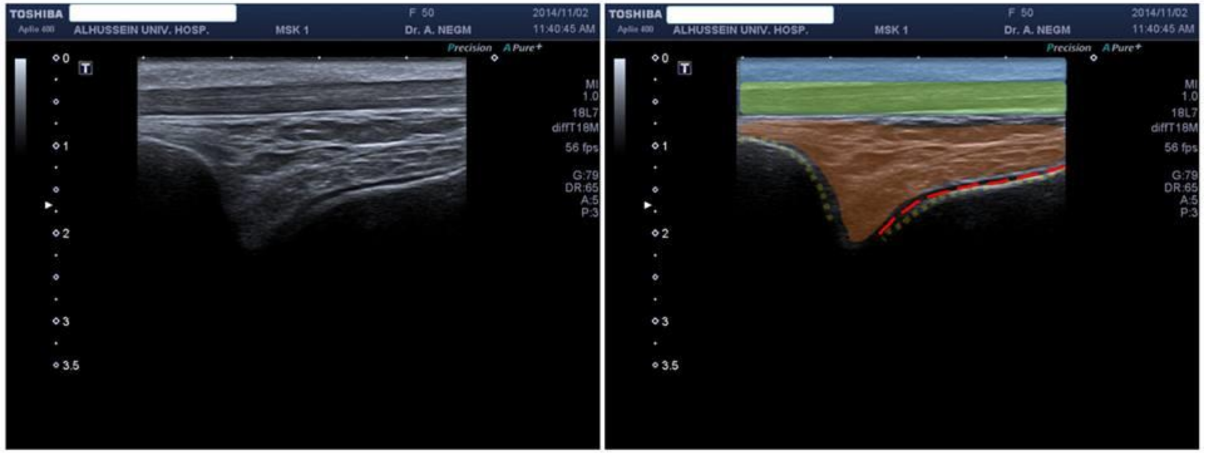
Beam focused by the acoustic lens



RECEIVING THE US REFLECTIONS/ECHOES

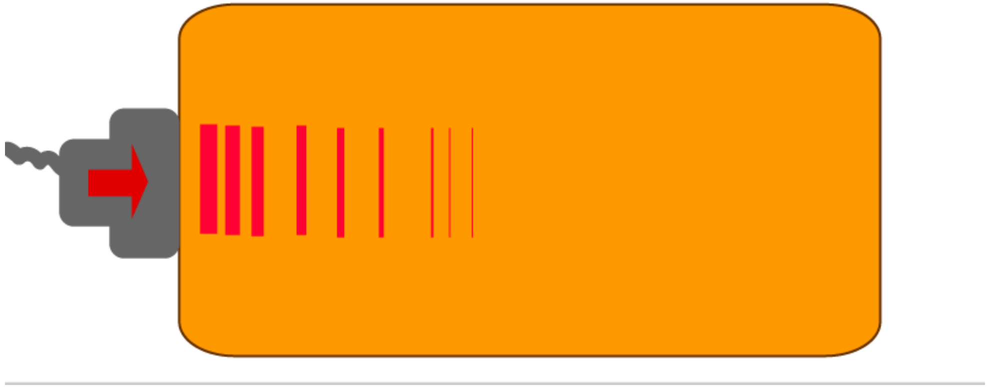


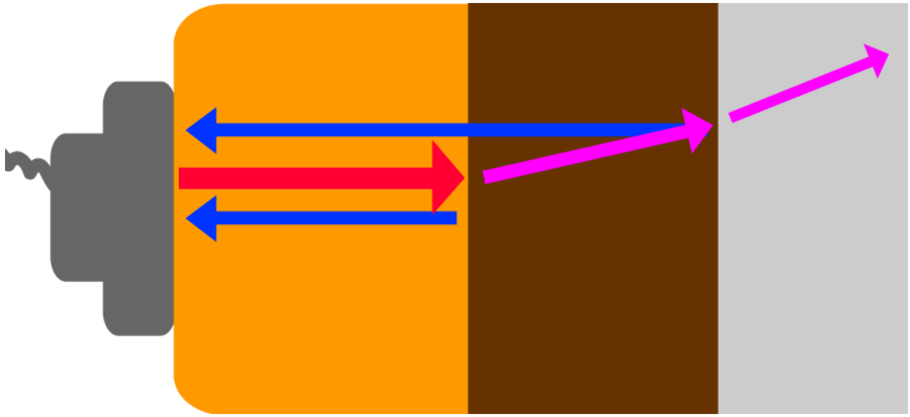
(a) Cadaver photo of ankle and foot, sagittal section



There is different degree of impedance mismatch at tissue interface

ATTENUATION (ENERGY LOSS)





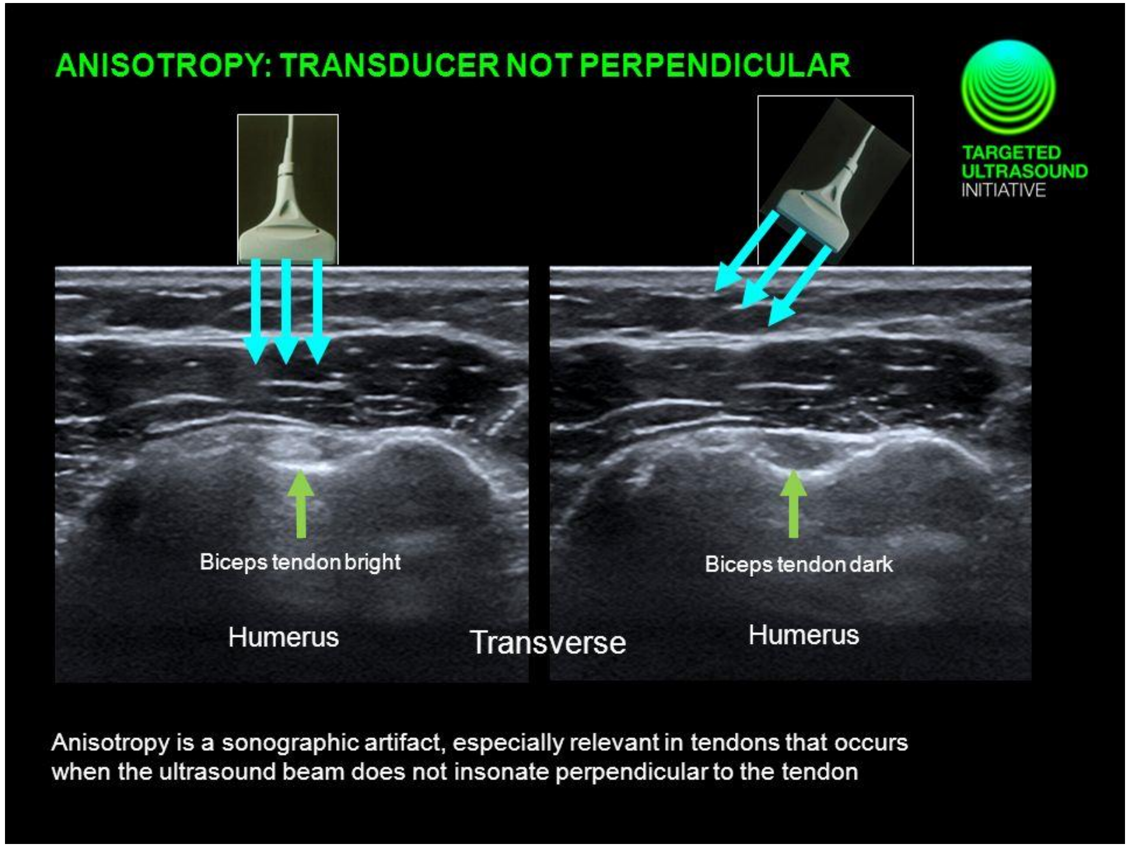
ATTENUATION (ENERGY LOSS)

- It is the loss of ultrasound as it propagates through a medium.
- Three components: absorption, scattering, and reflection.
- Attenuation always increases with depth affected by the frequency the type of tissue.

Frequency	**Attenuation**	**Tissue Penetration**
High	High	**Shallow**
Low	**Low**	**Deep**

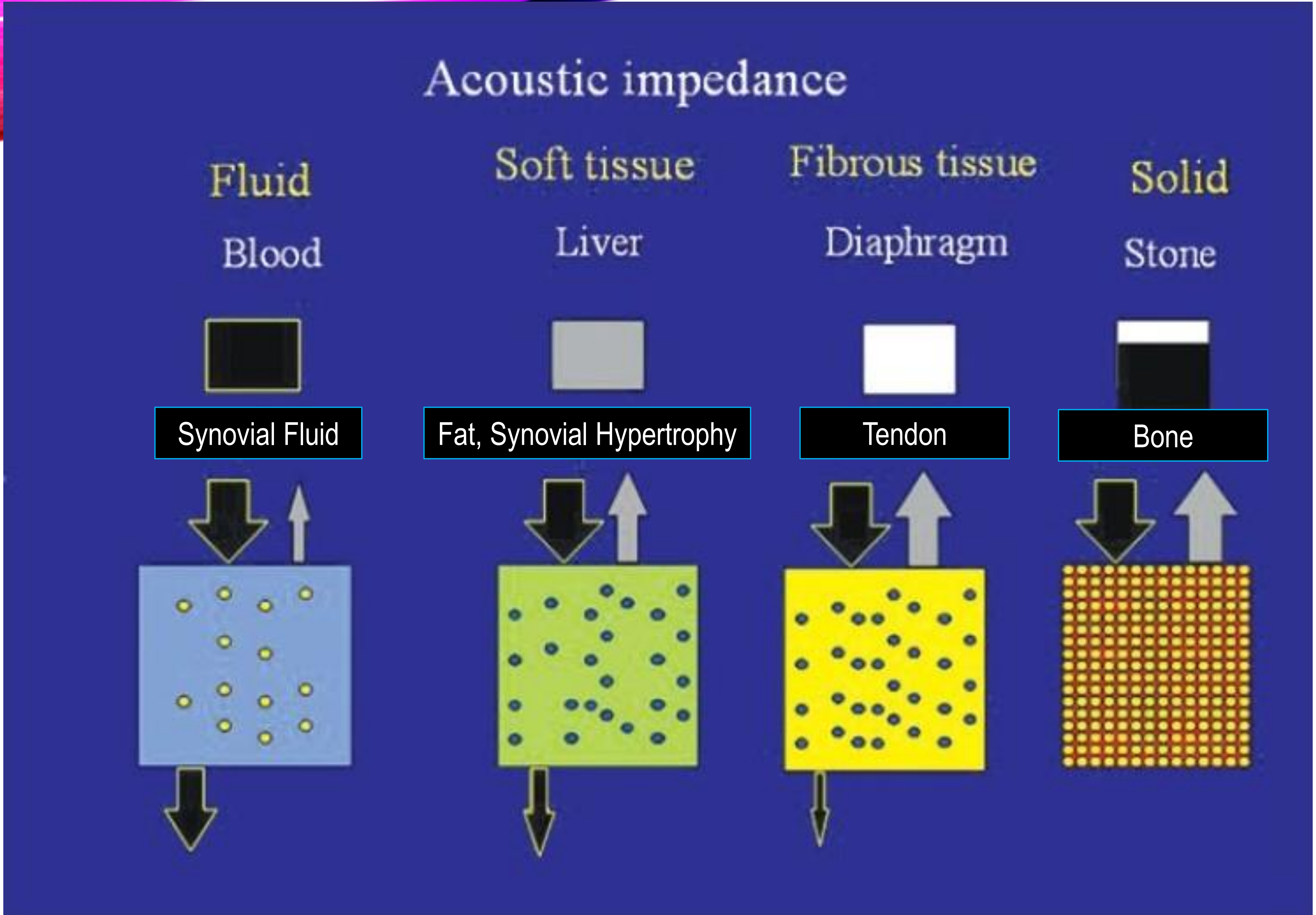
REFLECTION

- There is different degree of impedance mismatch at tissue interface→ different amount of reflection.
- Angle of the incidence
    - US wave hitting a smooth interface at a 90° angle will result in a perpendicular reflection
        - Strong, bright signal
    - US wave hitting the surface at an angle < 90° will result in the wave being deflected away from the transducer at an angle equal to the angle of incidence but in the opposite direction (angle of reflection)
        - Weak, darker image



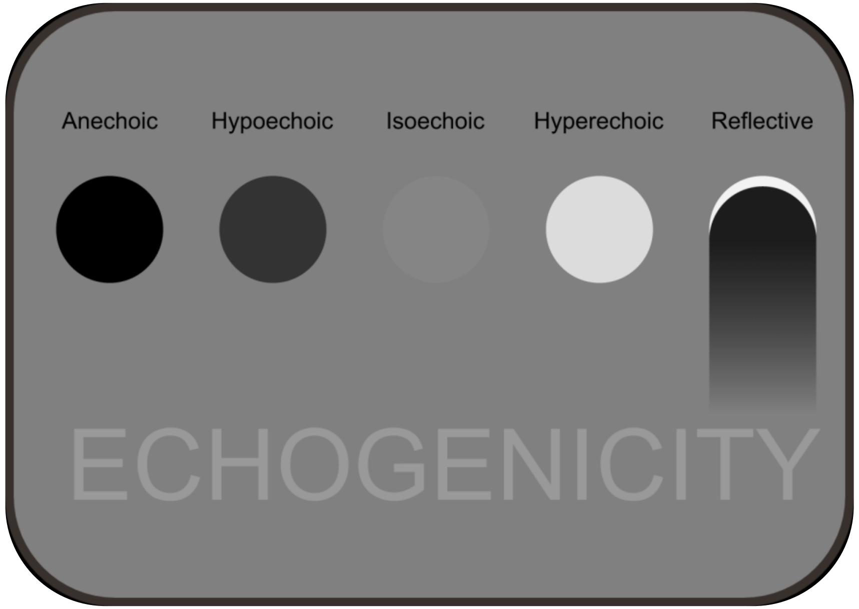
ANISOTROPY: TRANSDUCER NOT PERPENDICULAR

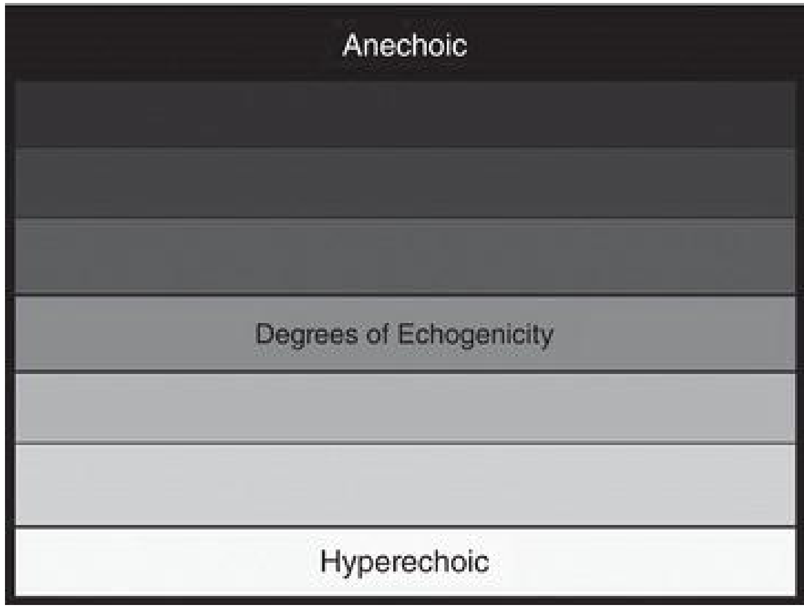
Anisotropy is a sonographic artifact, especially relevant in tendons that occurs when the ultrasound beam does not insonate perpendicular to the tendon


Acoustic impedance
Fluid
Blood
Soft tissue
Liver
Fibrous tissue
Diaphragm
Solid
Stone
Synovial Fluid
Fat, Synovial Hypertrophy
Tendon
Bone

ECHOGENICITY OF IMAGES ON THE MONITOR

- This phenomenon depends on the percentage of beam reflected.

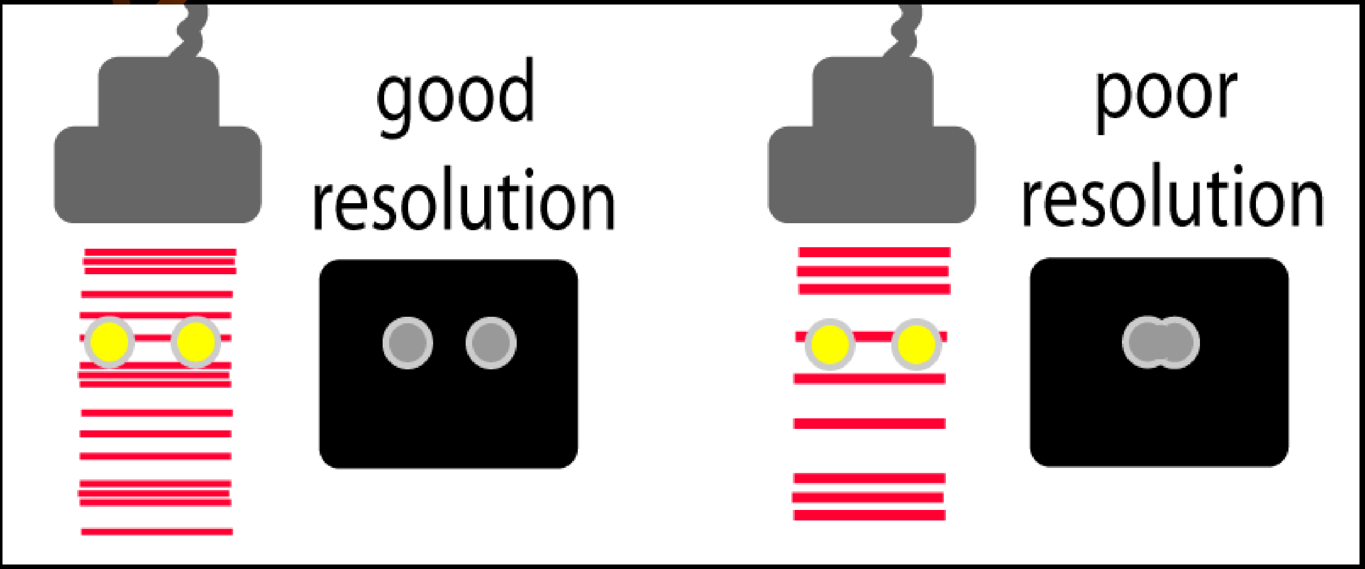

Anechoic
Hypoechoic
Isoechoic
Hyperechoic
Reflective
ECHOGENICITY

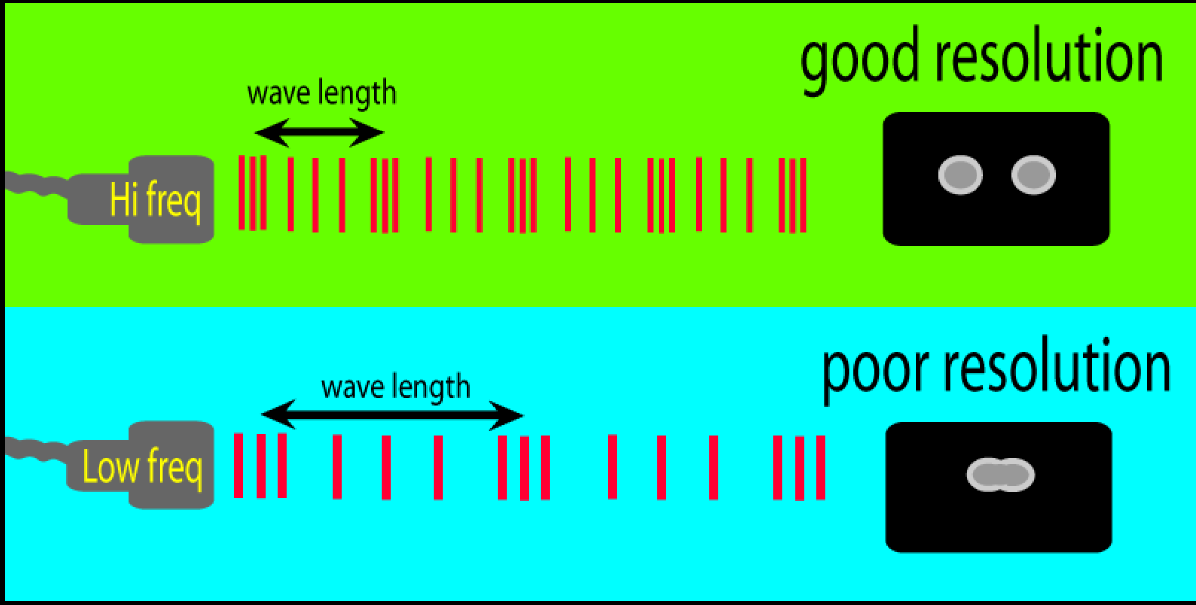

Anechoic
Degrees of Echogenicity
Hyperechoic

TISSUE APPEARANCES

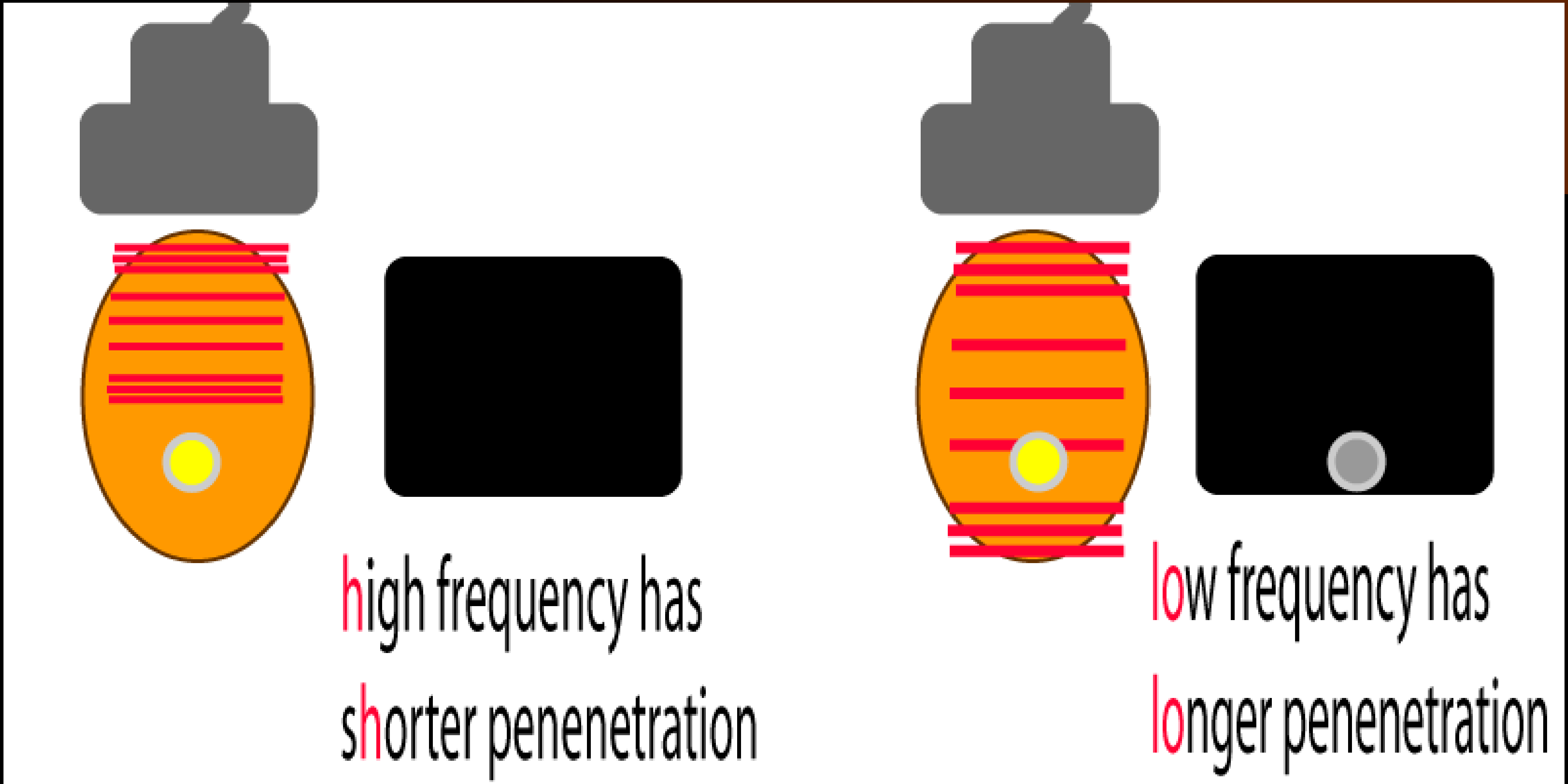
Tissue	US Image
Veins	Anechoic, compressible
Arteries	Anechoic, pulsatile
Fat	Hypoechoic with irregular hyperechoic lines
Muscle	Heterogeneous mixture of hyperechoic lines within a hypoechoic tissue
Tendon	Hyperechoic technical artifact (hypoechoic) fibrillar internal echotexture
Bone	++ hyperechoic lines with a hypoechoic shadow
Nerves	Hyperechoic/hypoechoic technical artifact (fascicle groups)

Resolution: is the ability to see two things as two things.



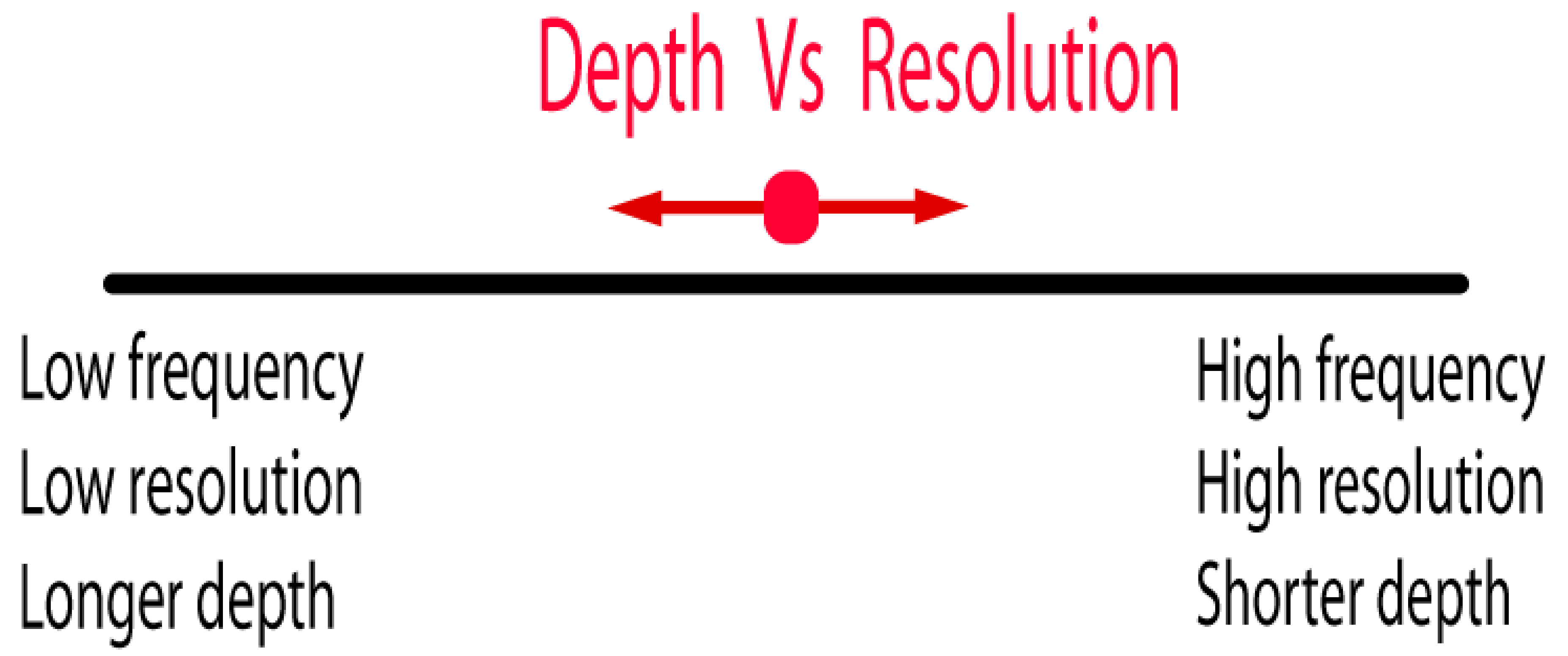


good resolution = short wavelength = high frequency



high frequency has shorter penenetration

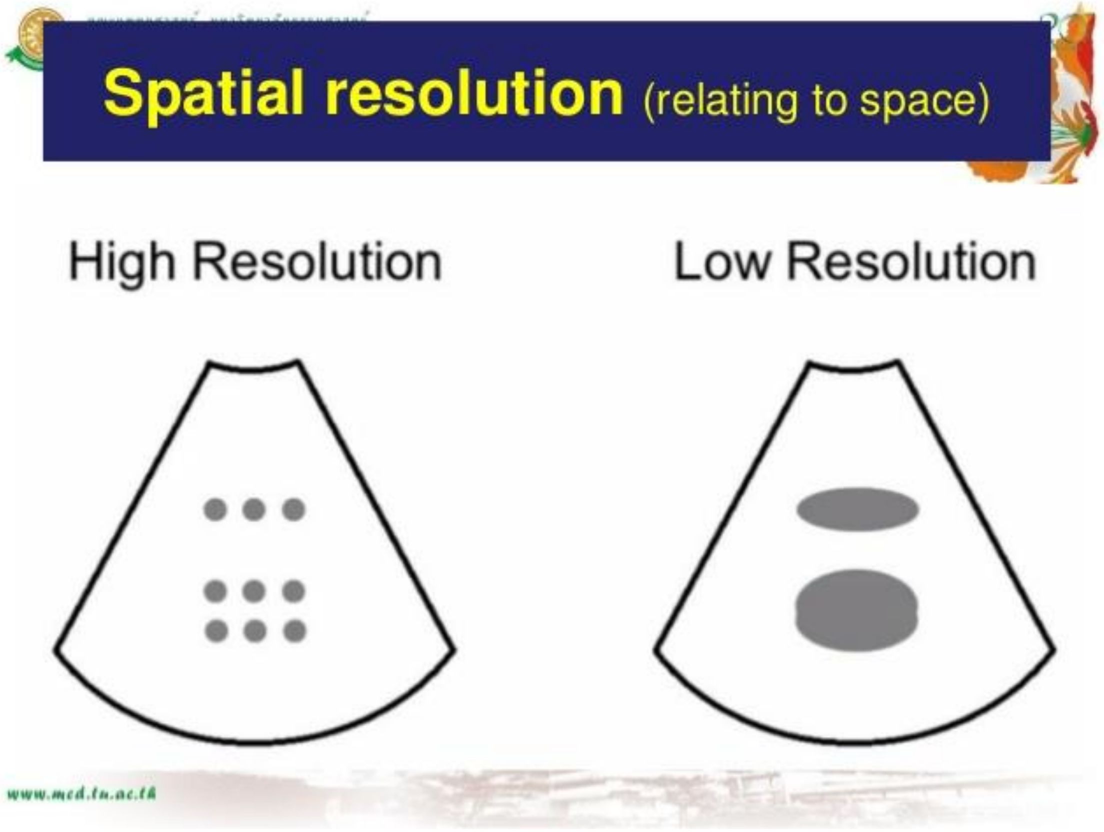
low frequency has longer penenetration



Depth Vs Resolution

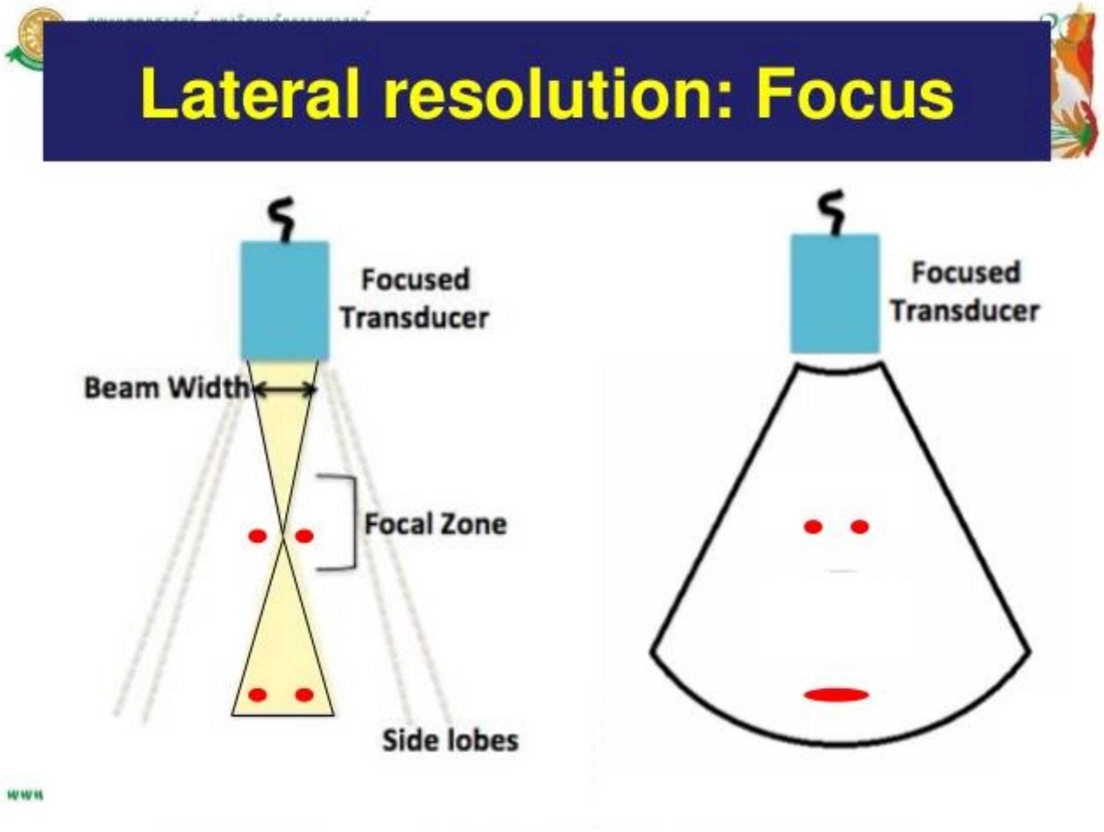
Low frequency	High frequency
Low resolution	High resolution
Longer depth	Shorter depth

RESOLUTION



Spatial resolution (relating to space)

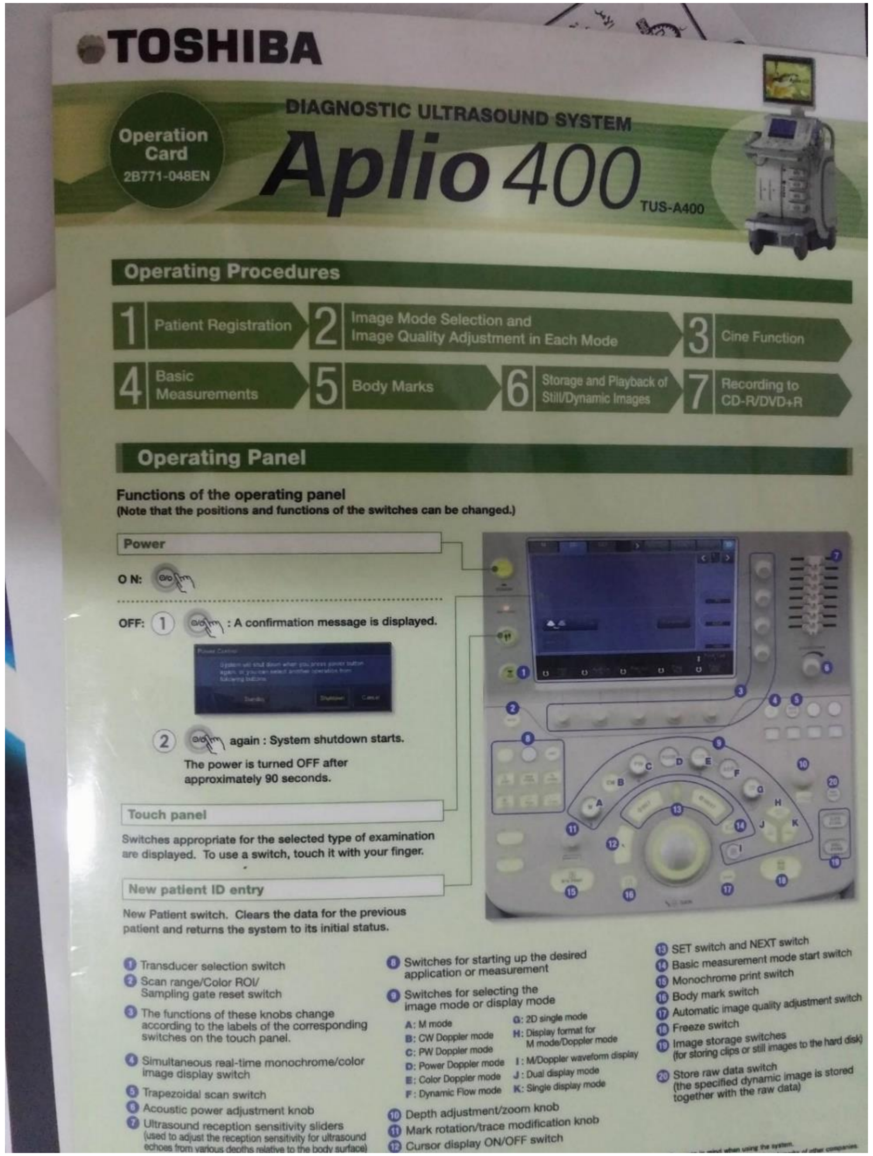
www.med.tu.ac.th



Lateral resolution: Focus

www

Knobology.
Noun. (Uncountable)
the functionality of controls on an instrument as relevant to their application.



TOSHIBA

Operation Card
2B771-048EN

DIAGNOSTIC ULTRASOUND SYSTEM
Aplio 400
TUS-A400

Operating Procedures

1 Patient Registration
2 Image Mode Selection and Image Quality Adjustment in Each Mode
3 Cine Function
4 Basic Measurements
5 Body Marks
6 Storage and Playback of Still/Dynamic Images
7 Recording to CD-R/DVD+R

Operating Panel

Functions of the operating panel
(Note that the positions and functions of the switches can be changed.)

Power

ON:

OFF: (1) : A confirmation message is displayed.

(2) again : System shutdown starts.
The power is turned OFF after approximately 90 seconds.

Touch panel

Switches appropriate for the selected type of examination are displayed. To use a switch, touch it with your finger.

New patient ID entry

New Patient switch. Clears the data for the previous patient and returns the system to its initial status.

① Transducer selection switch
② Scan range/Color ROI/ Sampling gate reset switch
③ The functions of these knobs change according to the labels of the corresponding switches on the touch panel.
④ Simultaneous real-time monochrome/color image display switch
⑤ Trapezoidal scan switch
⑥ Acoustic power adjustment knob
⑦ Ultrasound reception sensitivity sliders (used to adjust the reception sensitivity for ultrasound echoes from various depths relative to the body surface)
⑧ Switches for starting up the desired application or measurement
⑨ Switches for selecting the image mode or display mode
  - A: M mode
  - B: CW Doppler mode
  - C: PW Doppler mode
  - D: Power Doppler mode
  - E: Color Doppler mode
  - F: Dynamic Flow mode
  - G: 2D single mode
  - H: Display format for M mode/Doppler mode
  - I: M/Doppler waveform display
  - J: Dual display mode
  - K: Single display mode
⑩ Depth adjustment/zoom knob
⑪ Mark rotation/trace modification knob
⑫ Cursor display ON/OFF switch
⑬ SET switch and NEXT switch
⑭ Basic measurement mode start switch
⑮ Monochrome print switch
⑯ Body mark switch
⑰ Automatic image quality adjustment switch
⑱ Freeze switch
⑲ Image storage switches (for storing clips or still images to the hard disk)
⑳ Store raw data switch (the specified dynamic image is stored together with the raw data)

esaote

GAIN

- Changing the gain will change the amount of white, black, and gray on the monitor.
- Adjusting the gain of the image may improve the operator's ability to distinguish structures on the screen; the amount of gain to use depends on personal preference.
- Most US machines have an auto-gain knob, which is commonly used.

- Gain & time compensation (TGC)
  - Returning echoes are weak, so they must be amplified
  - Can be generally amplified (Overall gain)
  - Selectively amplify by depth (TGC slides)

DEPTH

- It is wise to begin with a somewhat higher depth setting in order to first get a "big picture", and then gradually decrease the depth when the targeted structure is found.
- For US-guided injection, the depth should be set about 1 cm deeper than the target of interest.

PROBE ORIENTATION

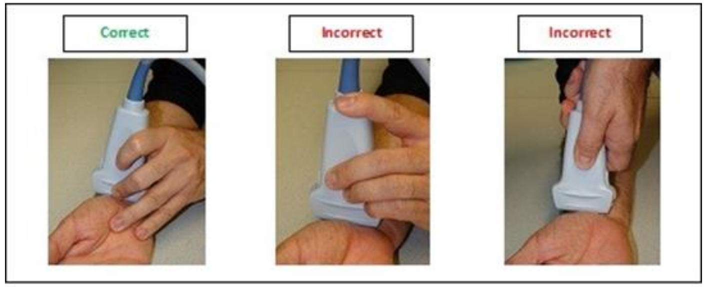
Probe orientation is important because the US probe can be easily rotated around (180 degree) while the position of the monitor remains unchanged, which may create confusion in the direction of probe manipulation and needle advancement and placement.

Therefore, it is always useful to confirm which side of the probe corresponds to a particular side of the screen in order to identify the correct orientation of the image.

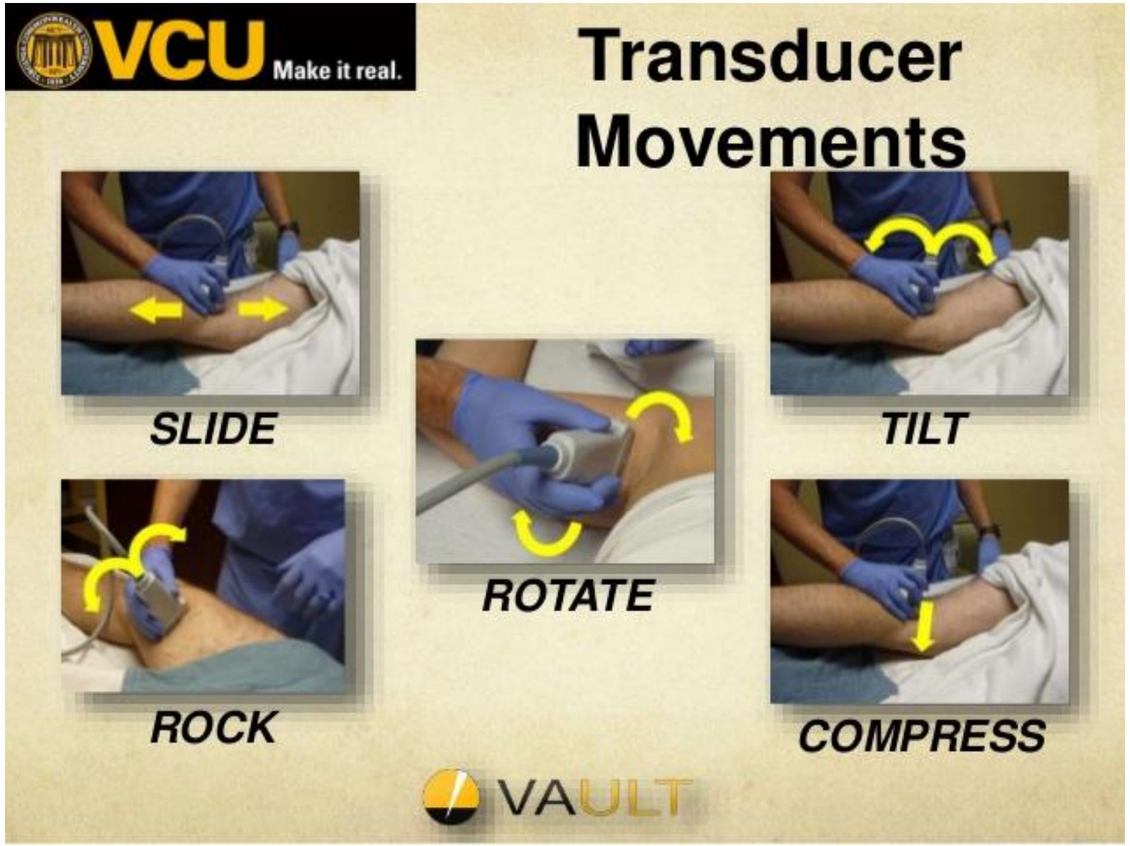
All transducers have an orientation marker that corresponds to the marker on the screen.

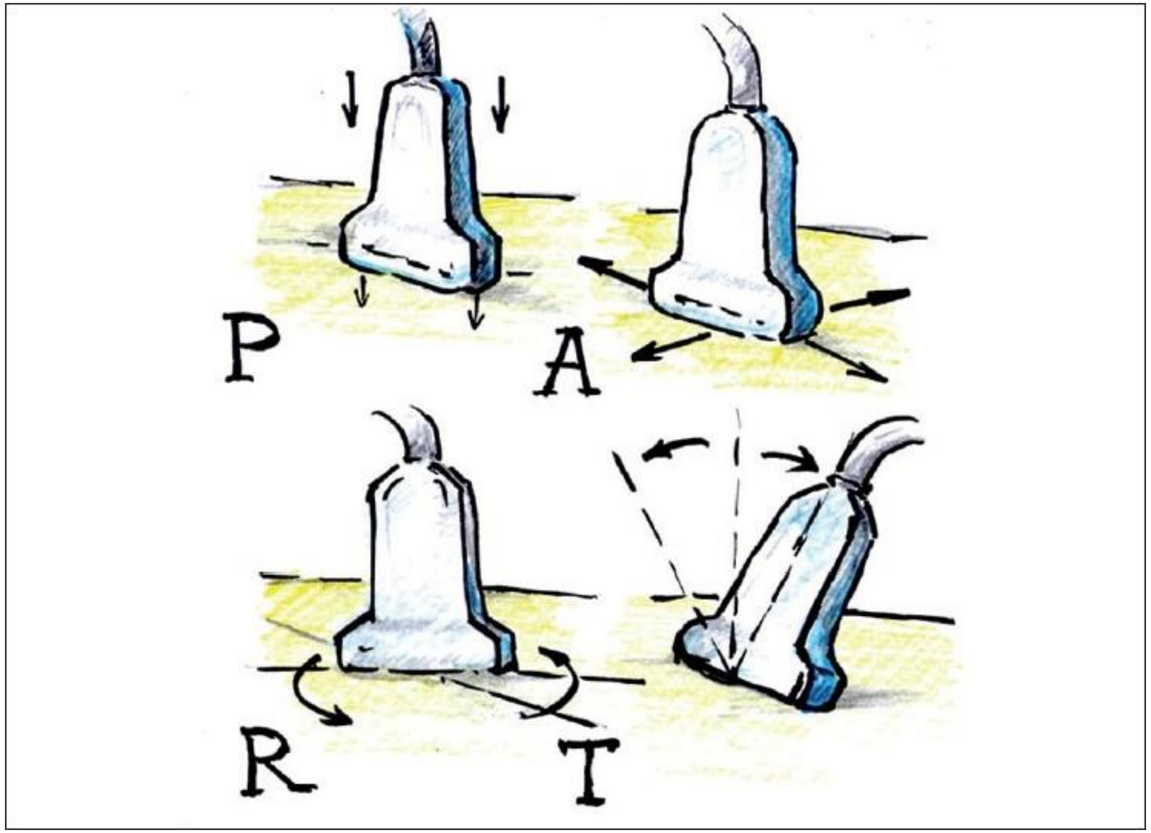
BASIC SCANNING INTRODUCTION

- Select appropriate transducer
- Coupling gel
  - Transducer
  - Skin
- Stabilize transducer
  - Anchor hand/transducer with 5th finger on patient
- Move focal zone on screen to level at area of interest



PROBE MANIPULATION

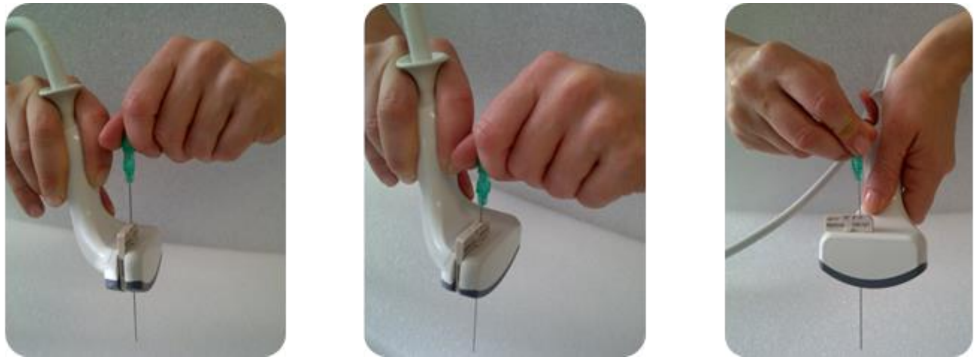




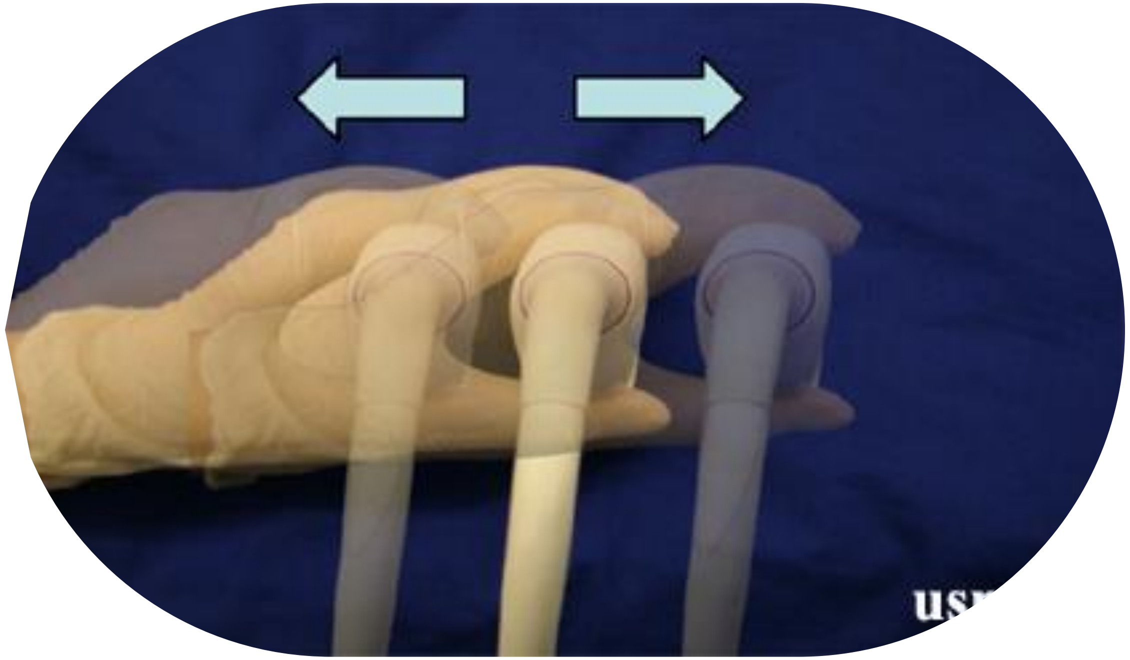
"PART" mnemonic for Pressure, Alignment, Rotation and Tilt as fundamental probe manipulation

FUTURE IS NOW!

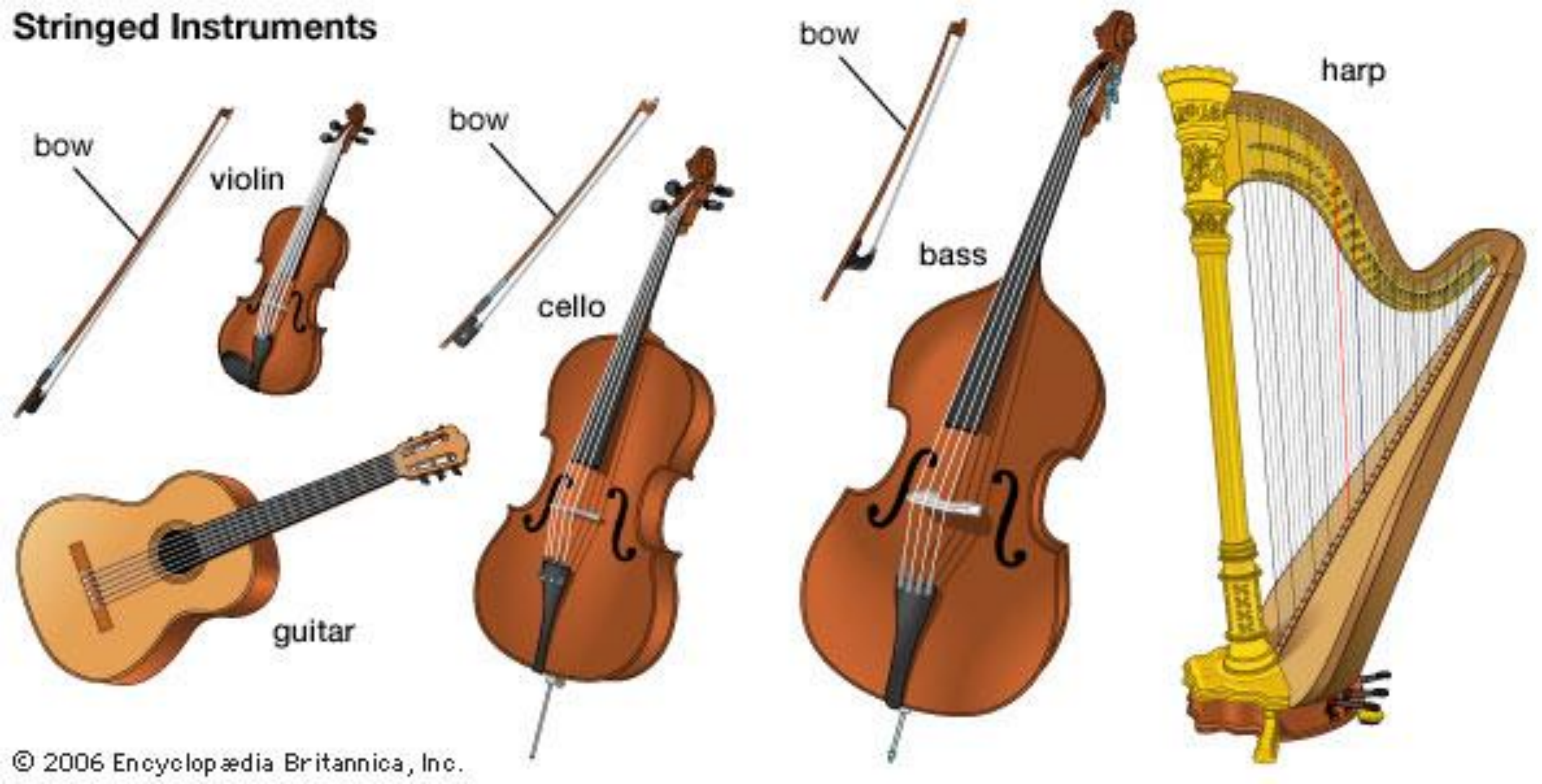
EASE OF USE!



REMEMBER



Choose you instrument!



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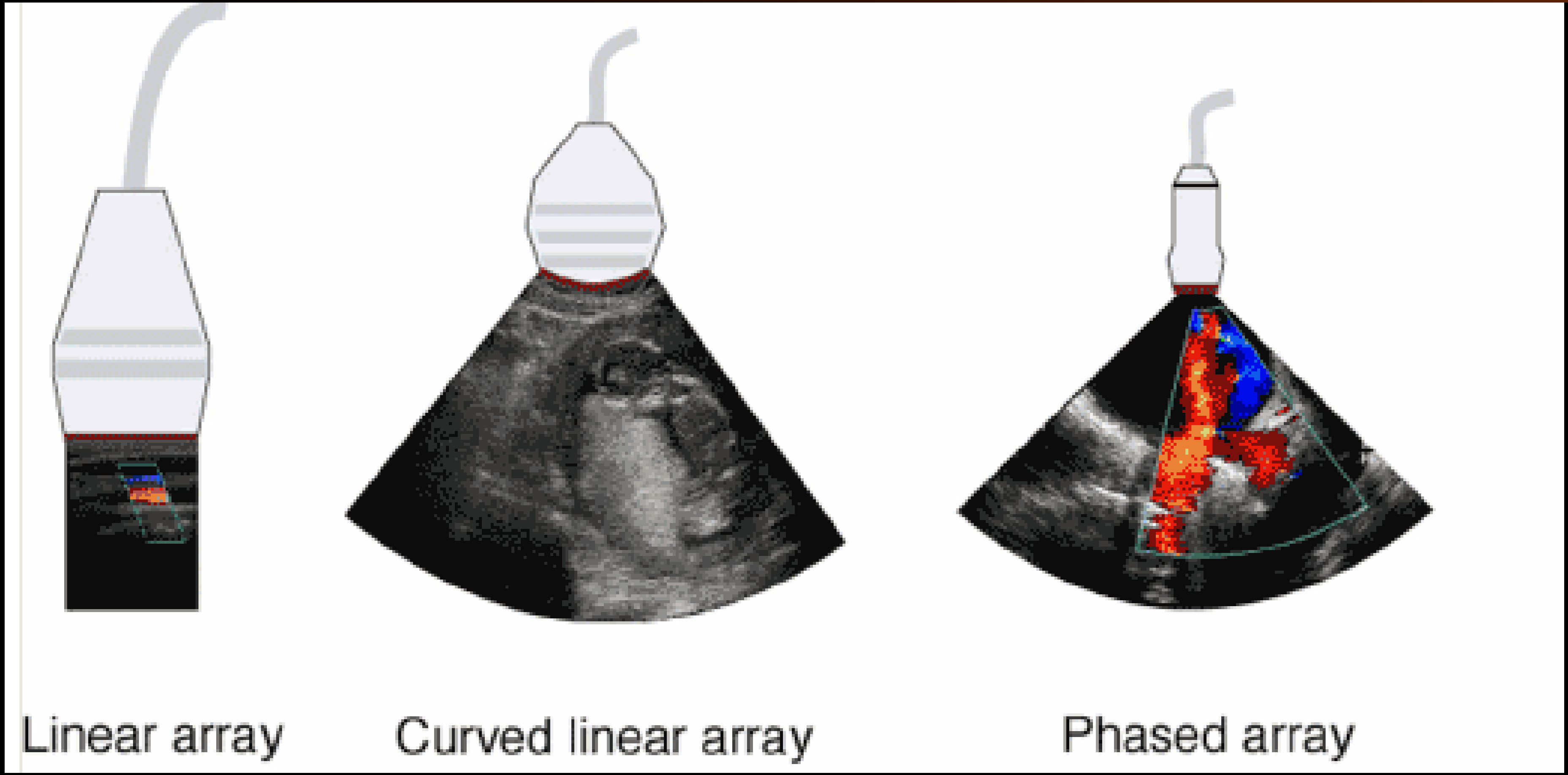
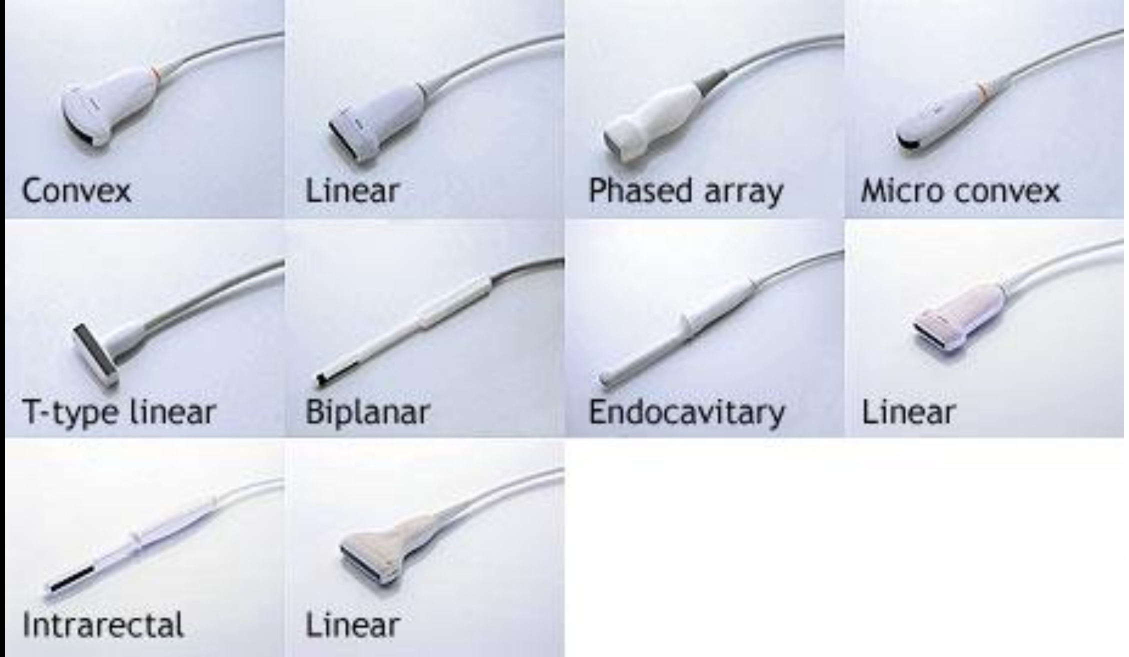
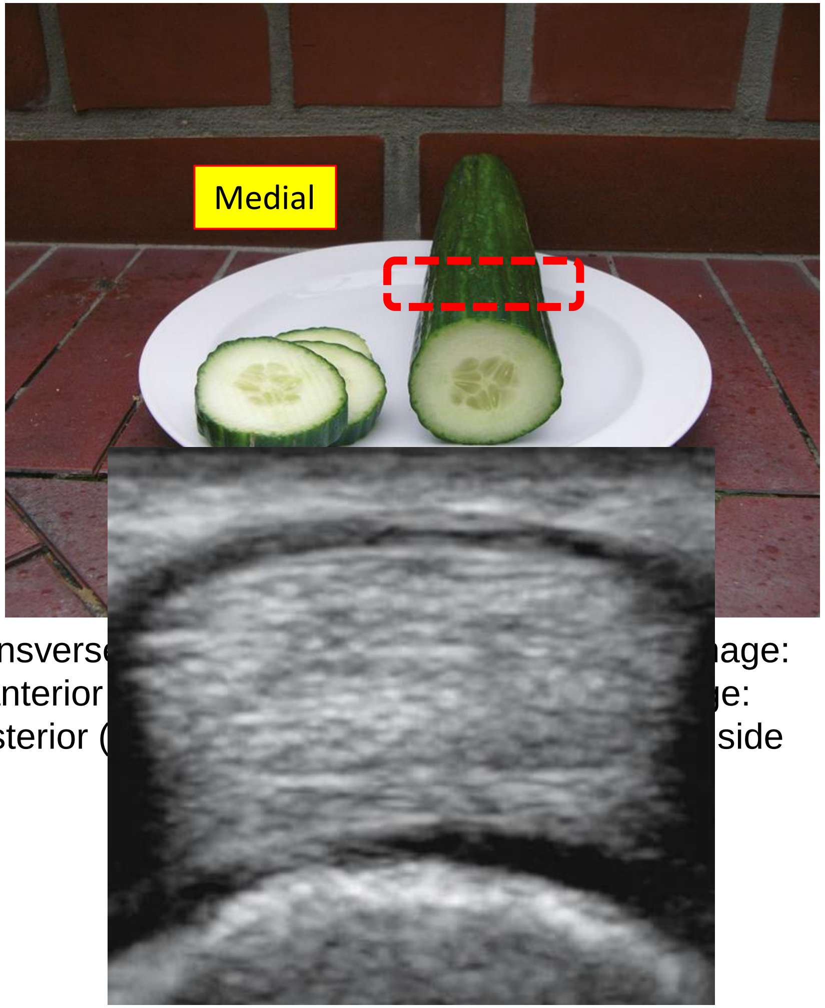
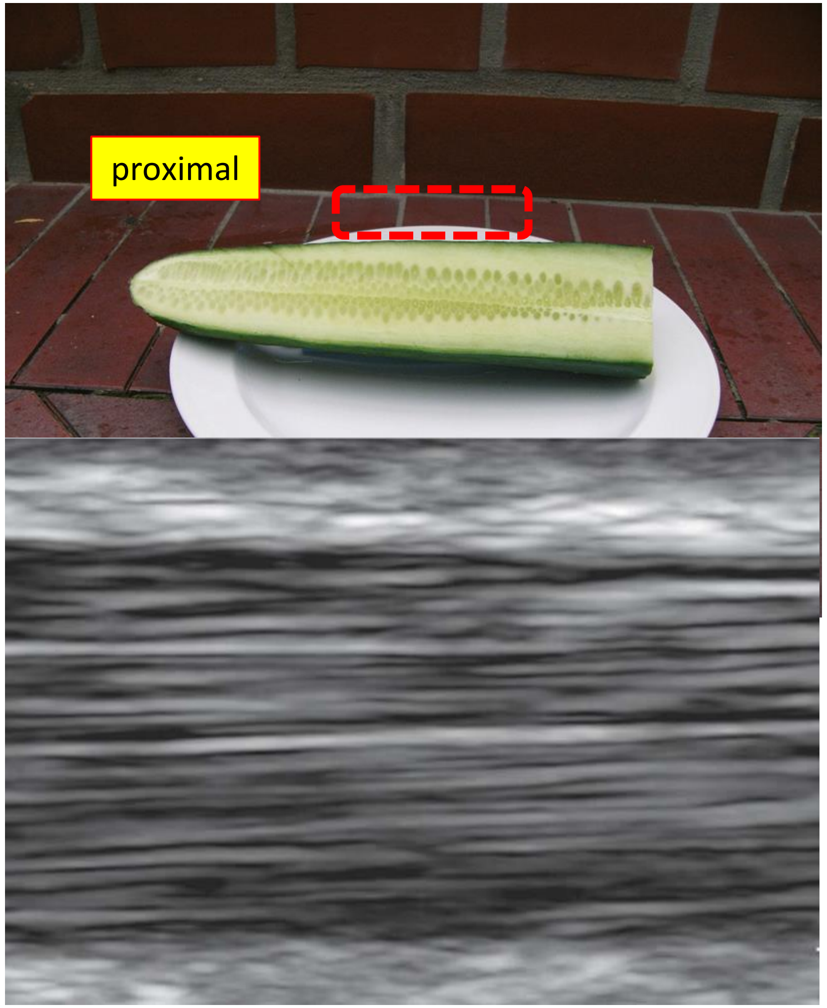

Linear array
Curved linear array
Phased array

Probe

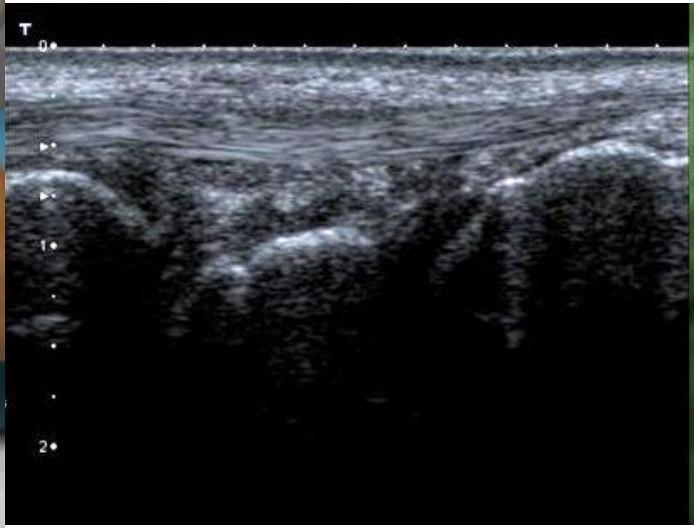

Convex
Linear
Phased array
Micro convex
T-type linear
Biplanar
Endocavitary
Linear
Intrarectal
Linear

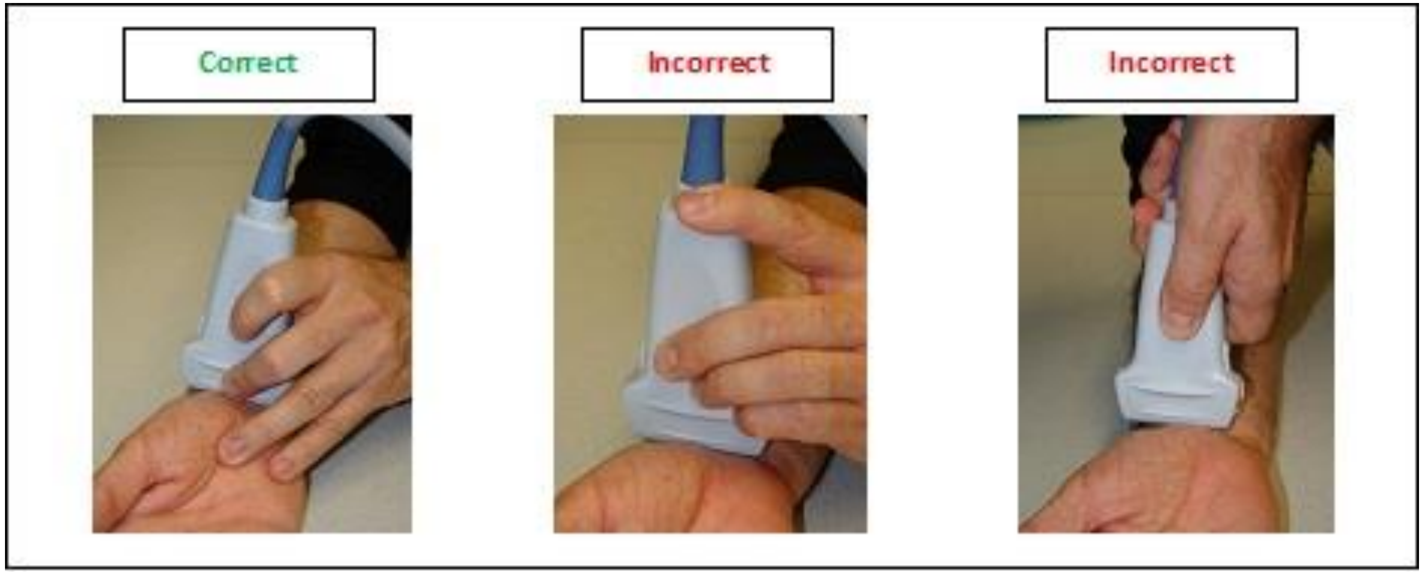


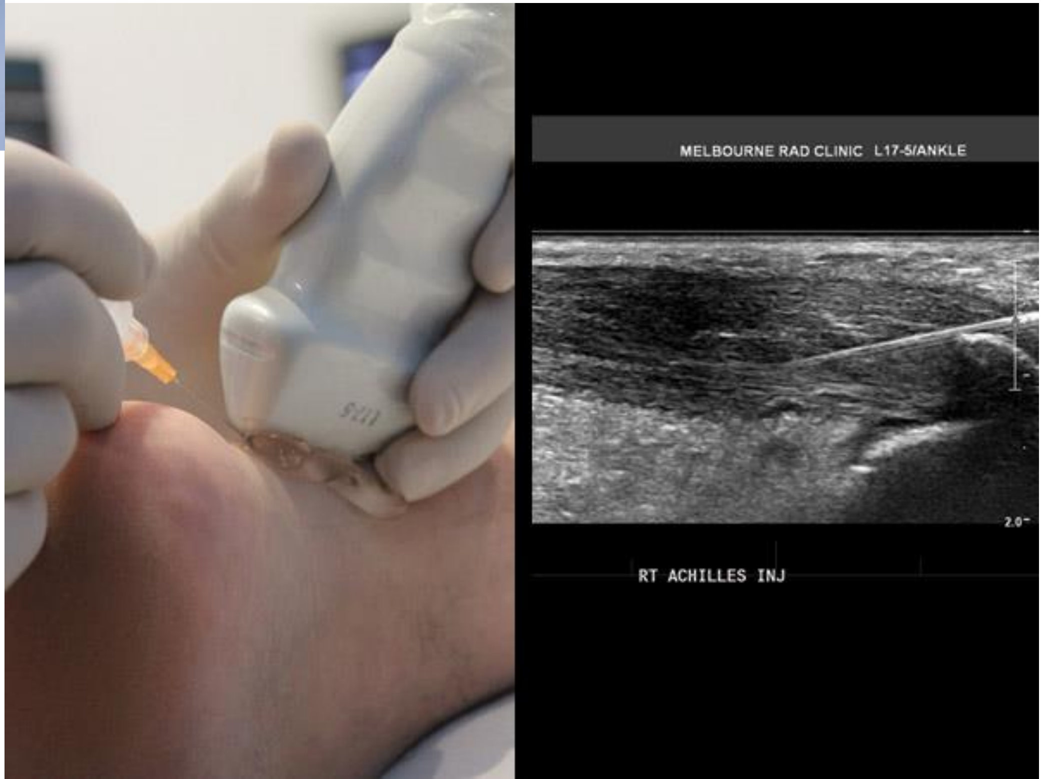
Transvers age:
anterior ge:
posterior (side



Probe Placement






MELBOURNE RAD CLINIC L17-5/ANKLE
2.0
RT ACHILLES INJ

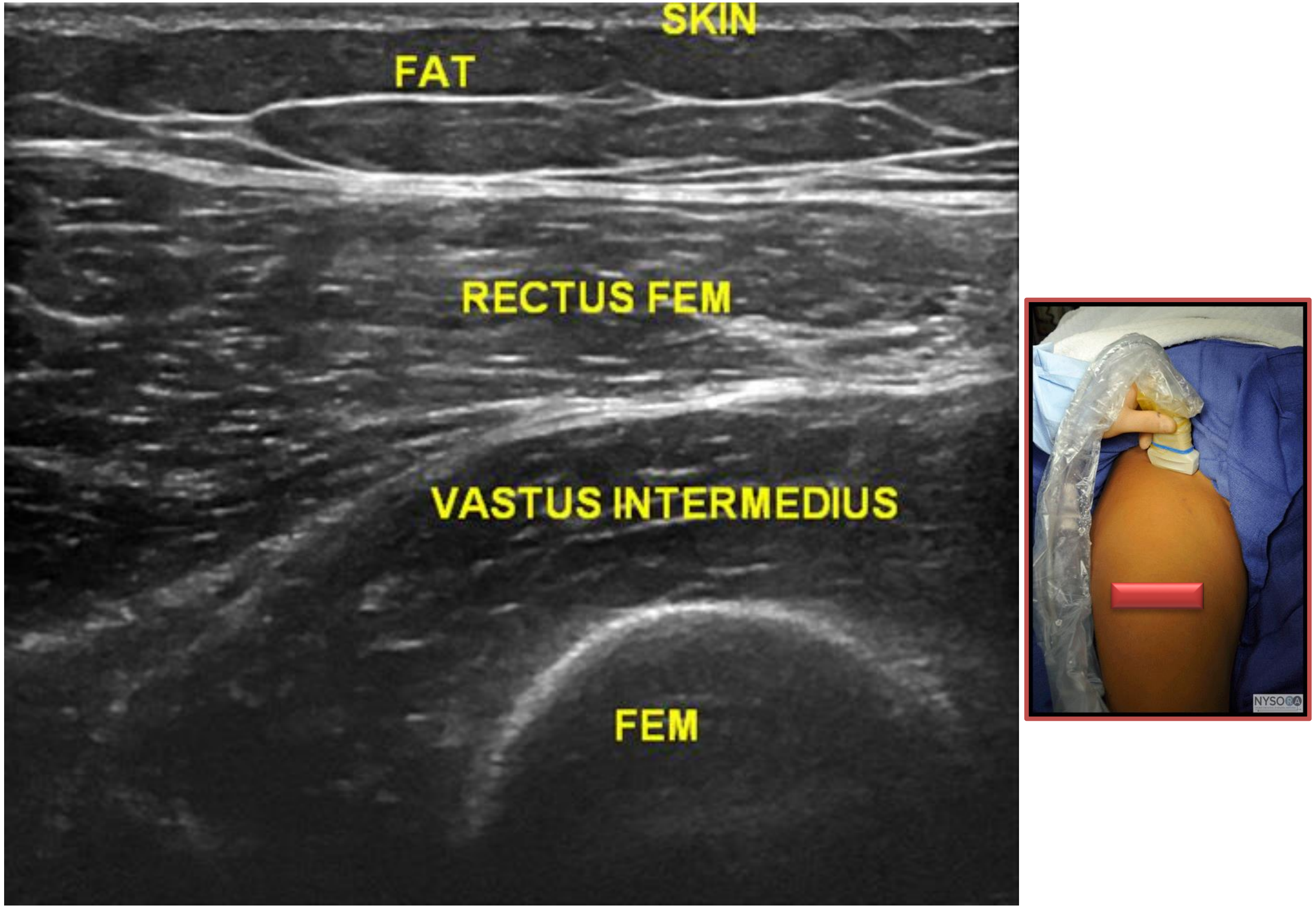
Identify normal structures in musculoskeletal ultrasound (MSUS)

Skin

- For imaging of the skin with sonography high frequency transducers (>13 MHz) are necessary.
- For patients with scleroderma investigators have suggested that high frequency
- (20 MHz) sonography is a feasible method for measuring skin thickness and stiffness (elastography) and they advise sonography for diagnosis, long-term follow-up, and assessment of therapeutic studies.

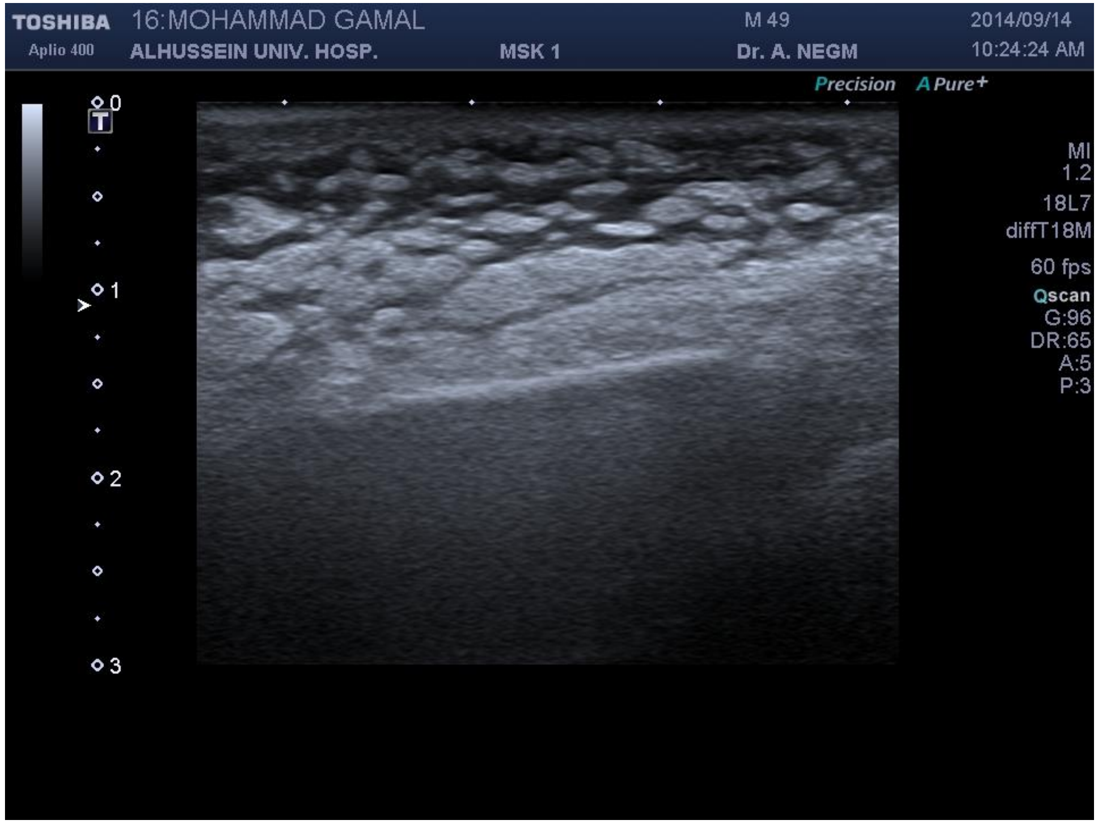
Fat

- Fat is hypoechoic with thin horizontal hyperechoic striae inside being connective tissue fibers.
- Lipomas are often hyperechoic compared to the surrounding hypoechoic fat



Transverse image upper leg shows skin (hyperechoic) on top and fat (hypoechoic) underneath Fat underneath the skin.

SC Oedema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Aplio 400
16:MOHAMMAD GAMAL
ALHUSSEIN UNIV. HOSP.
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M 49
Dr. A. NEGM
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Precision
A Pure+
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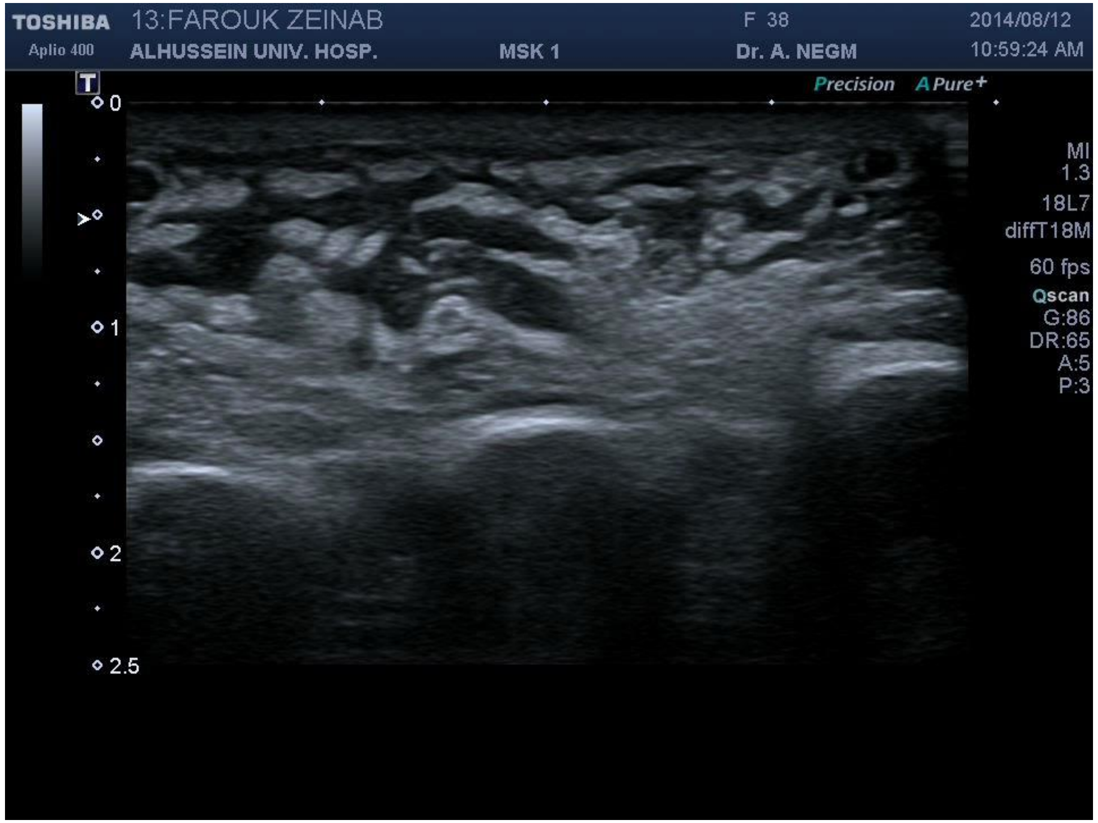
diffT18M
60 fps
Qscan
G:96
DR:65
A:5
P:3


TOSHIBA
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18L7
diffT18M
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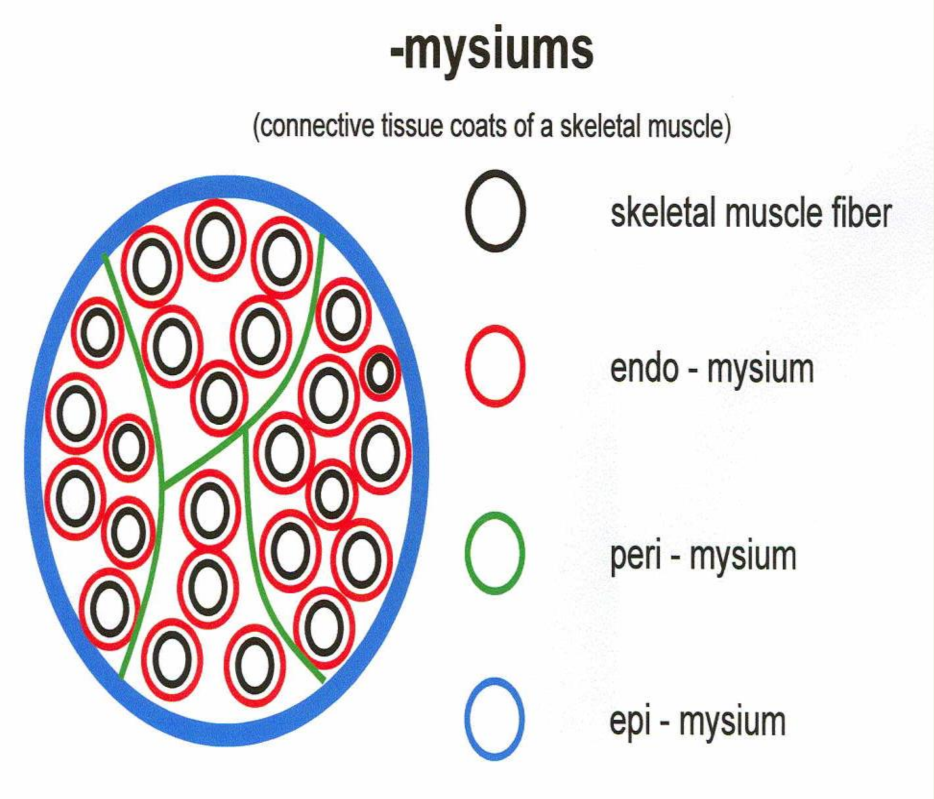
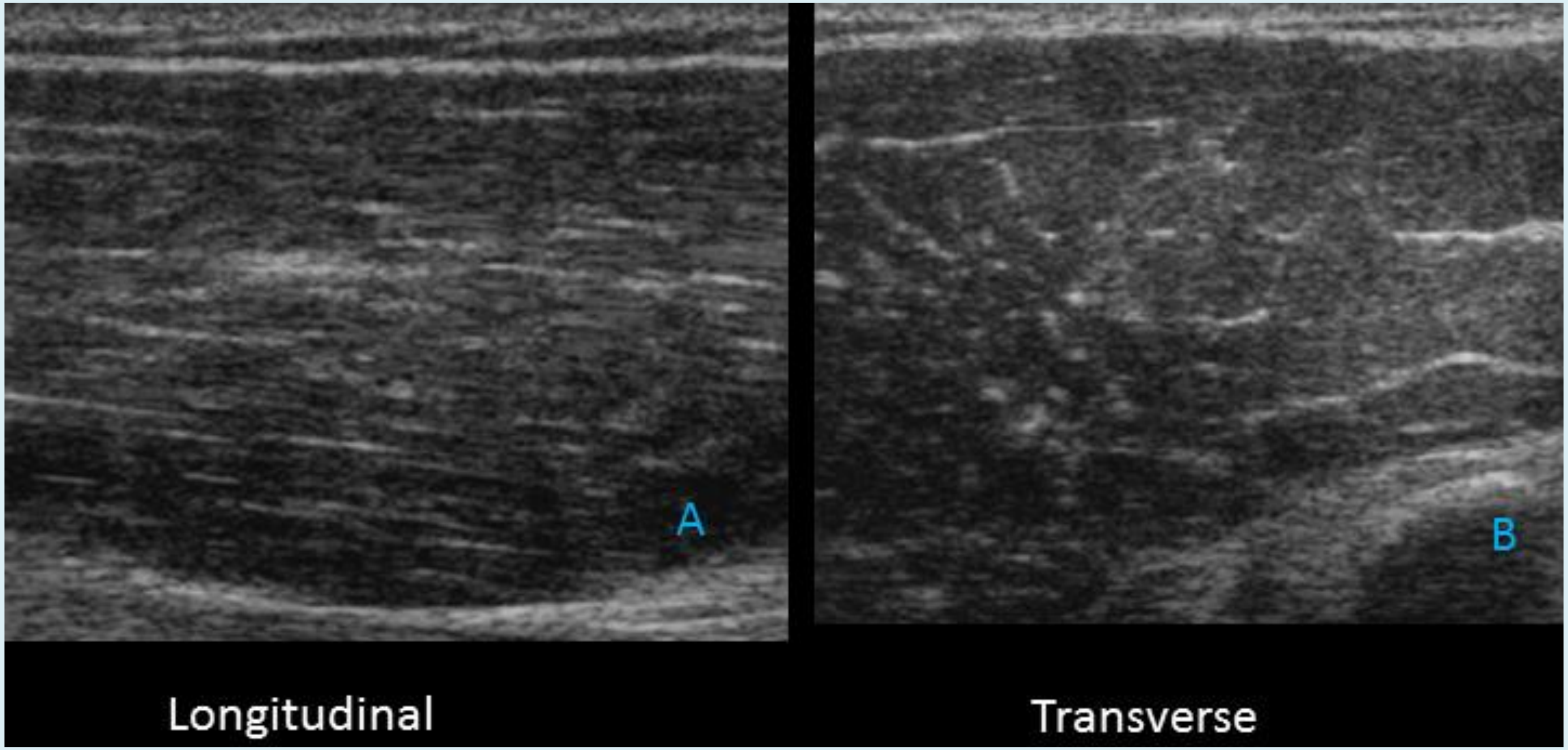
Qscan
G:86
DR:65
A:5
P:3

Muscle

- Muscles appear on a longitudinal image hypoechoic with parallel and oblique echoic fibers, corresponding to the endomysium, perimysium and epimysium).
- On a transverse image muscle is hypoechoic with multiple echoic dots, corresponding to the cross-sections of the endomysium, perimysium and epimysium .

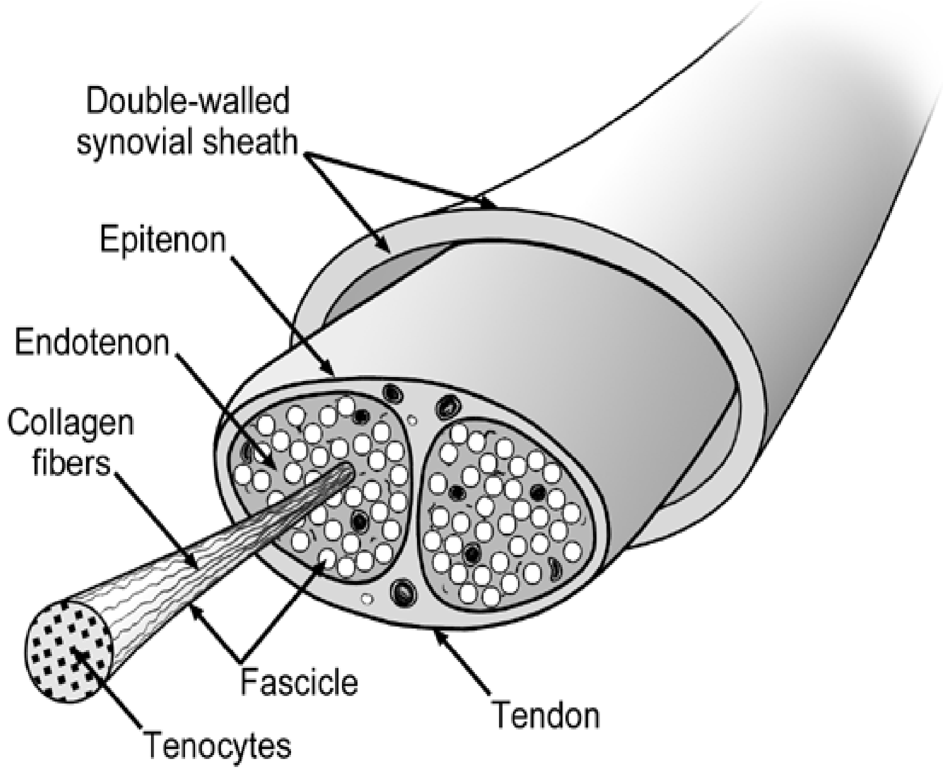


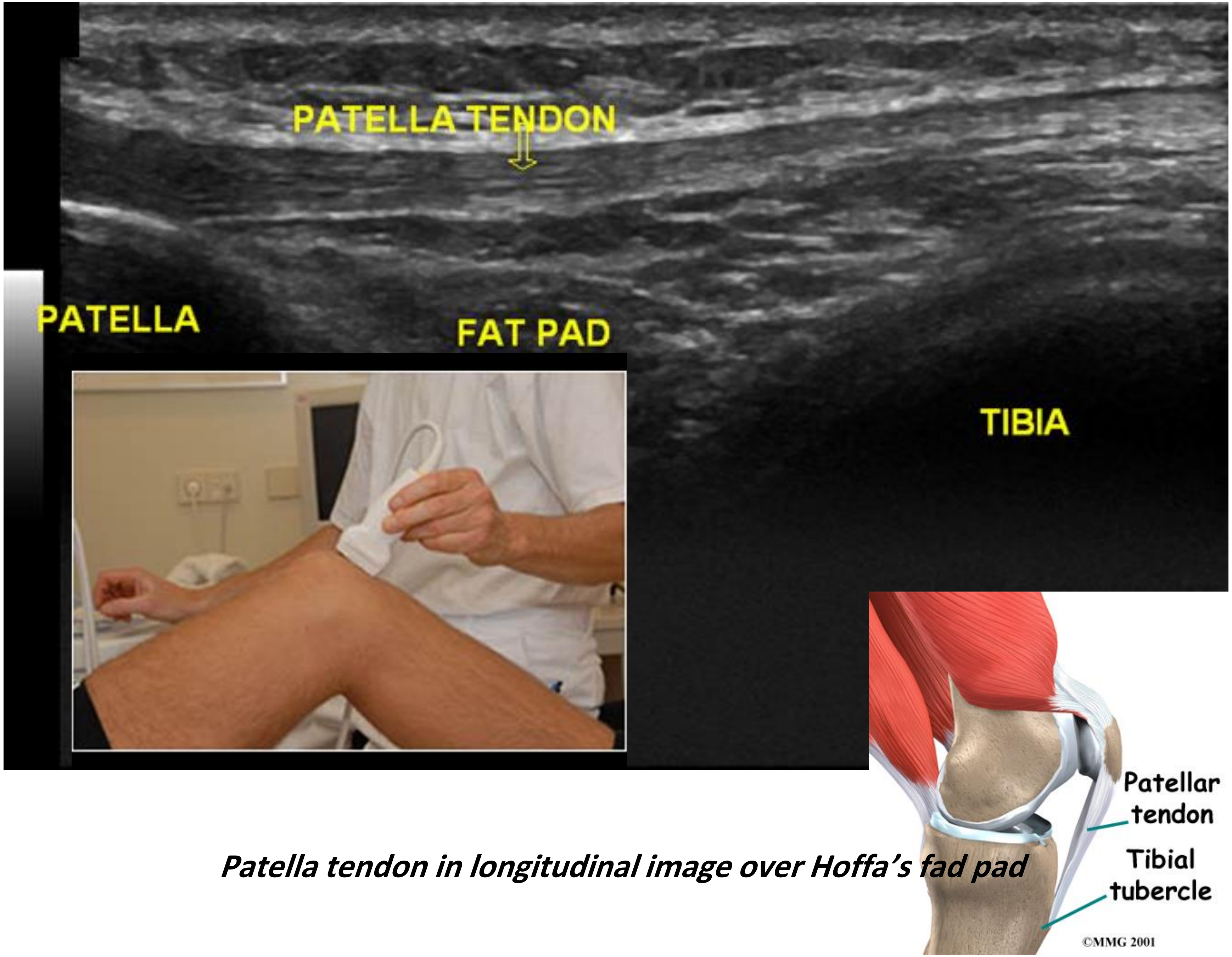


A. Longitudinal: feathery structure; B. Transverse: speckled aspect of muscle

Tendons

- Longitudinal imaging of tendons shows a typical network of linear hyperechoic fibrillar patterns on US when the insonation angle is 90 degrees.
- The echogenic fibrils are the sonographic reflection of the endotendineal and peritendineal septa.





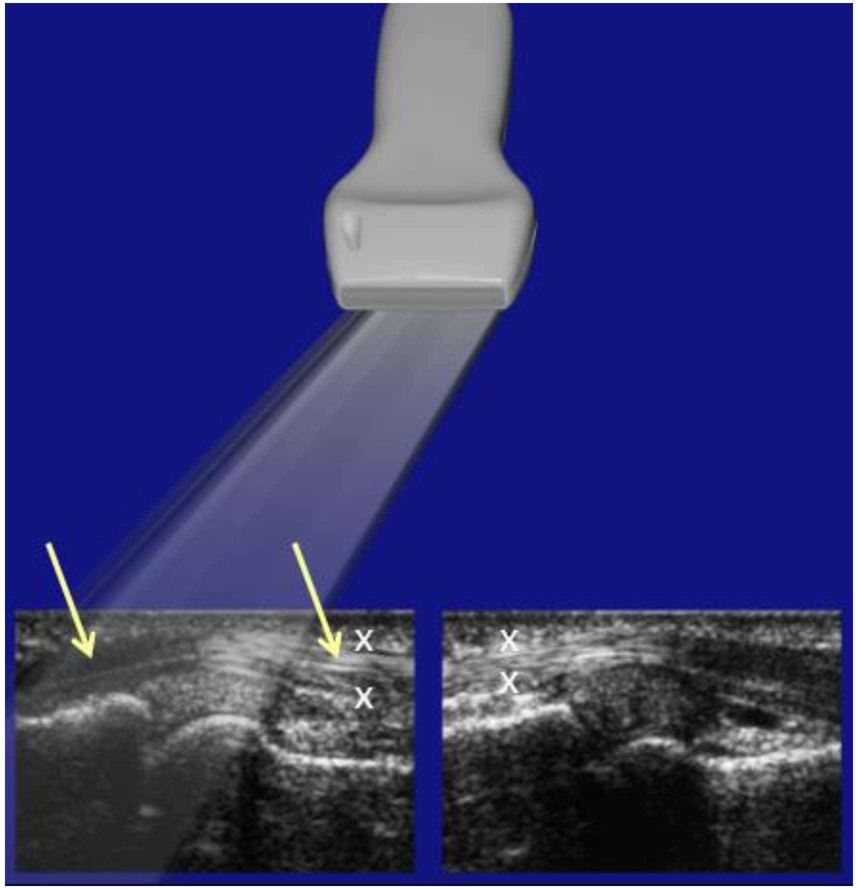
Patella tendon in longitudinal image over Hoffa's fad pad

Anisotropy

Anisotropy

Anisotropy

- may occur when the insonation angle is not 90 degrees and is an artifact that makes the tendon look hypoechoic(dark) in parts

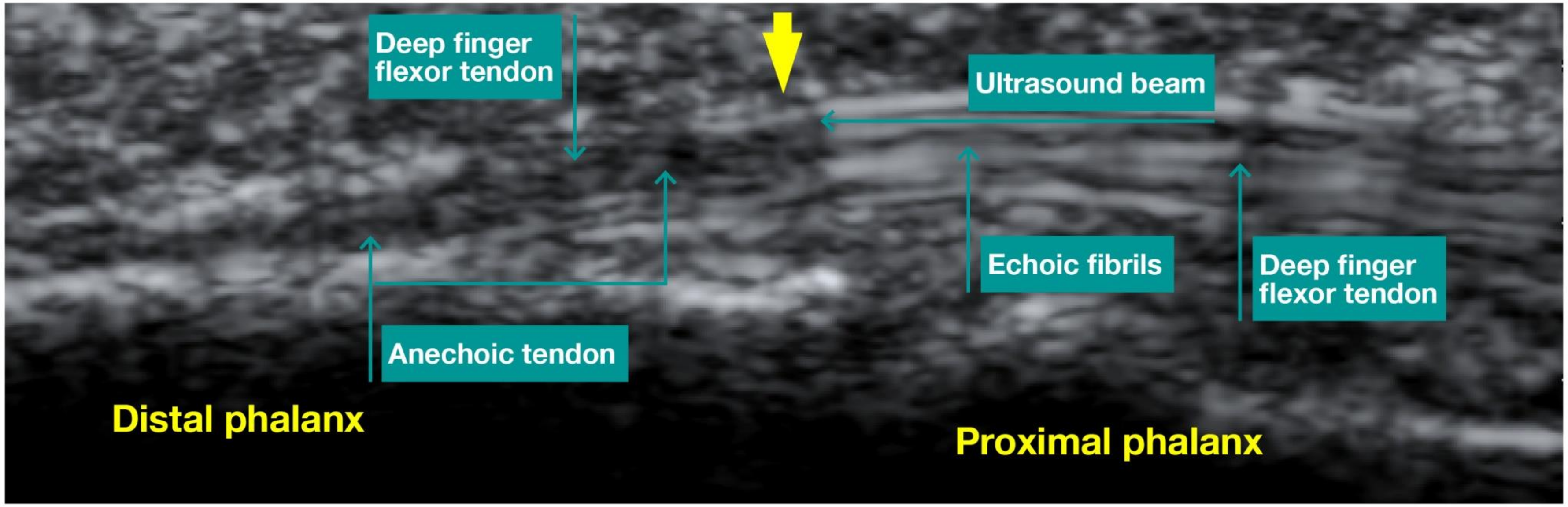


TARGETED
ULTRASOUND
INITIATIVE

PROBE POSITIONING

Healthy Subject (finger flexor tendons). Anisotropy.

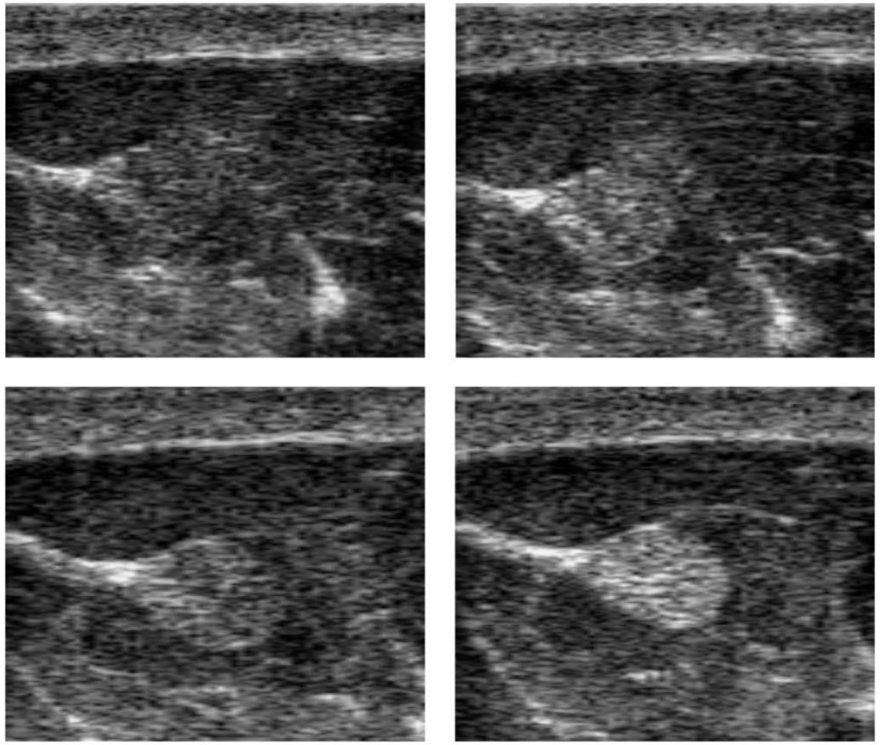
This longitudinal volar scan shows that anisotropy can also be generated from small variations of the major axis of the fibrils tendon compared to that of the ultrasound beam.



PROBE POSITIONING

Healthy Subject (flexor pollicis longus. Anisotrophy can be caused by even minimal changes of the probe inclination.

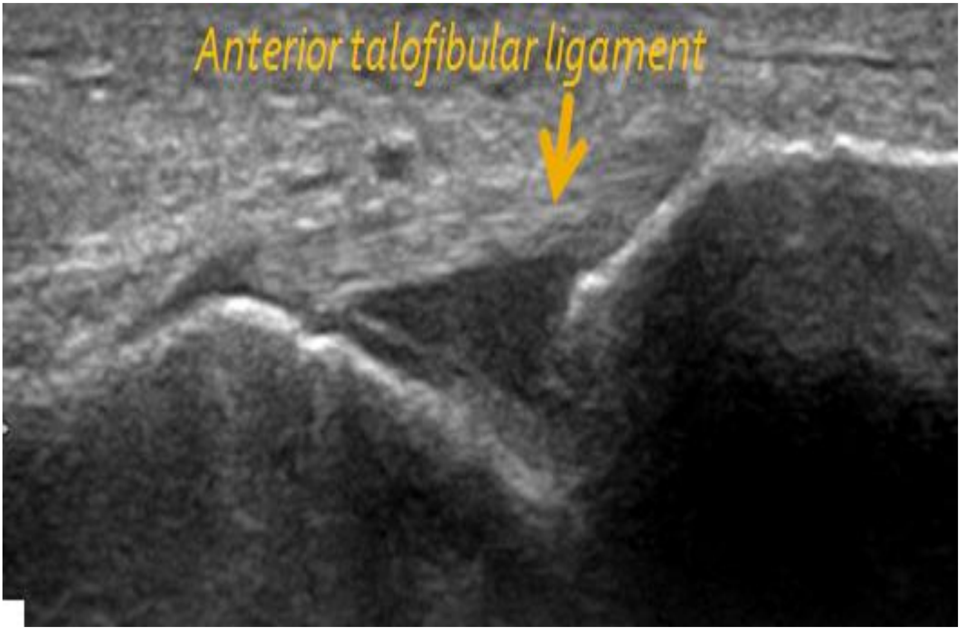
Incorrect probe inclination



Correct probe inclination

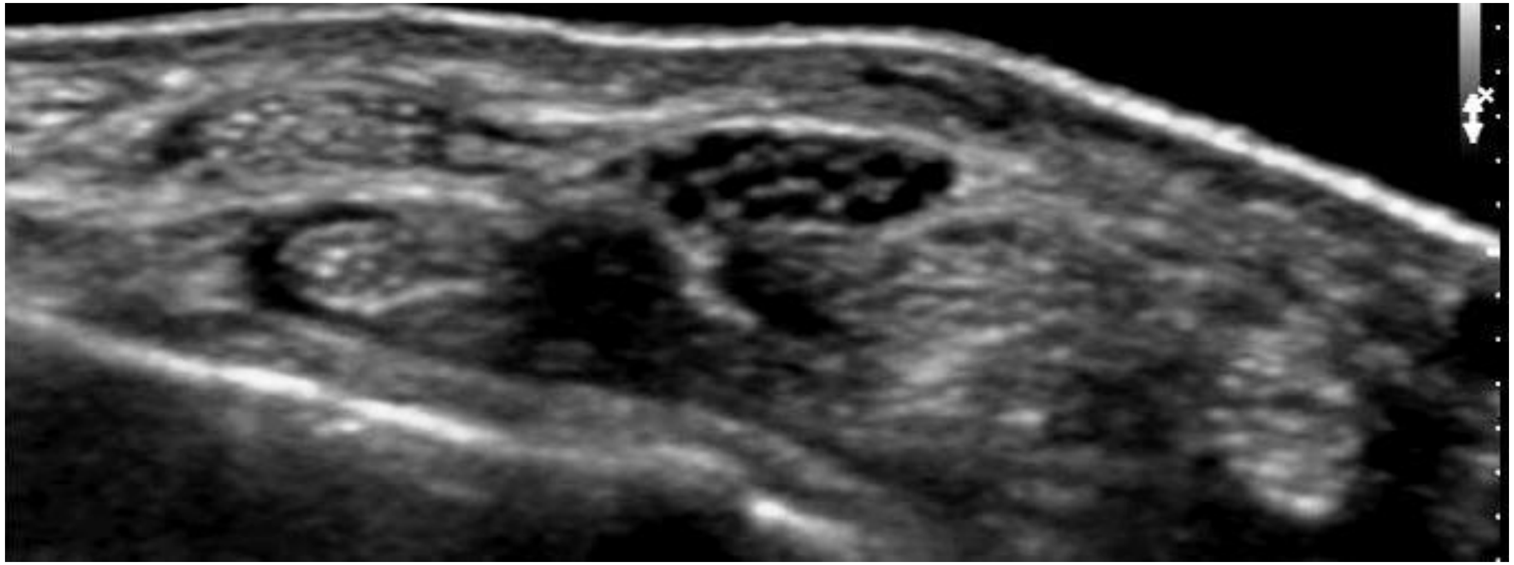
Ligaments

- They are hyperechoic, with a compact fibrillar pattern.
- Ligaments, like tendons, will appear swollen and hypoechoic when damaged after trauma.
- Rupture of ligaments may also be visualized by sonography.



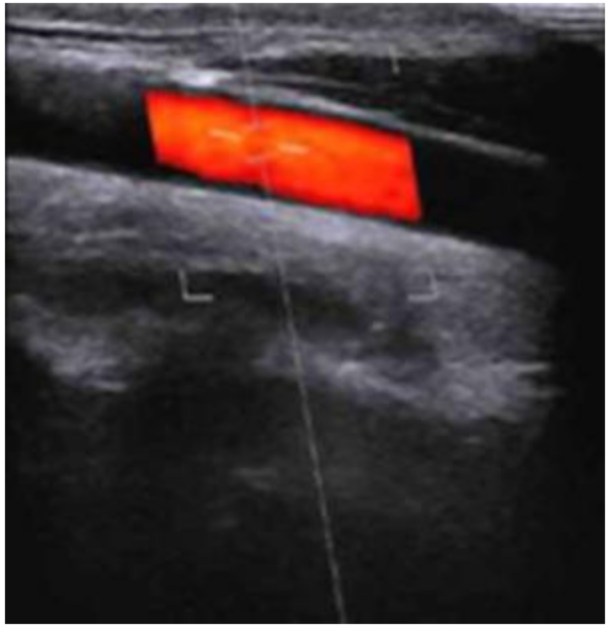
Nerves

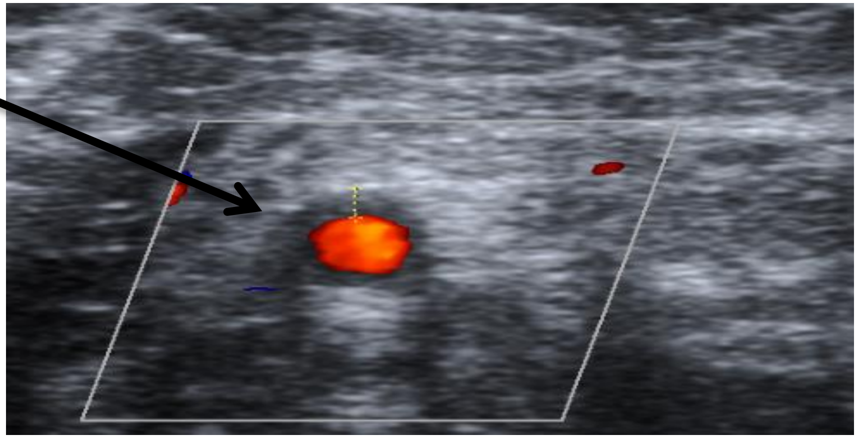
- Peripheral nerves appear hyperechoic.
- On longitudinal scans the internal structure of nerves is characterized by linear hypoechoic areas corresponding with the fascicles, separated by hyperechoic bands corresponding with the endoneurium and perineurium. Outside the nerve parallel hyperechoic bands are found which correspond with the epineurium.
- When peripheral nerves are compressed, e.g. by other tissues, they appear swollen and less hyperechoic.



Blood vessels

- visualized as anechoic longitudinal tubular structures in the longitudinal plane and a round structure in the transverse plane that may be compressed.
- In case of temporal arteriitis a dark halo might be detected within the vessel wall





Periosteum

- Normally periosteum is not visible, but can be seen as a white line over an hypoechoic or anechoic mass when it is lifted up from the underlaying bone, e.g. by an hematoma or subperiosteal abscess as part of osteomyelitis

Bone

- A very bright echo is produced at the interface of soft tissue and bone cortex as bone is a very good reflector of ultrasound waves.
- Bright echoes are also observed in the case of soft tissue calcification and ossification.
- Cortical erosions in RA can be seen as a cortical defect in two planes earlier than with x-ray.

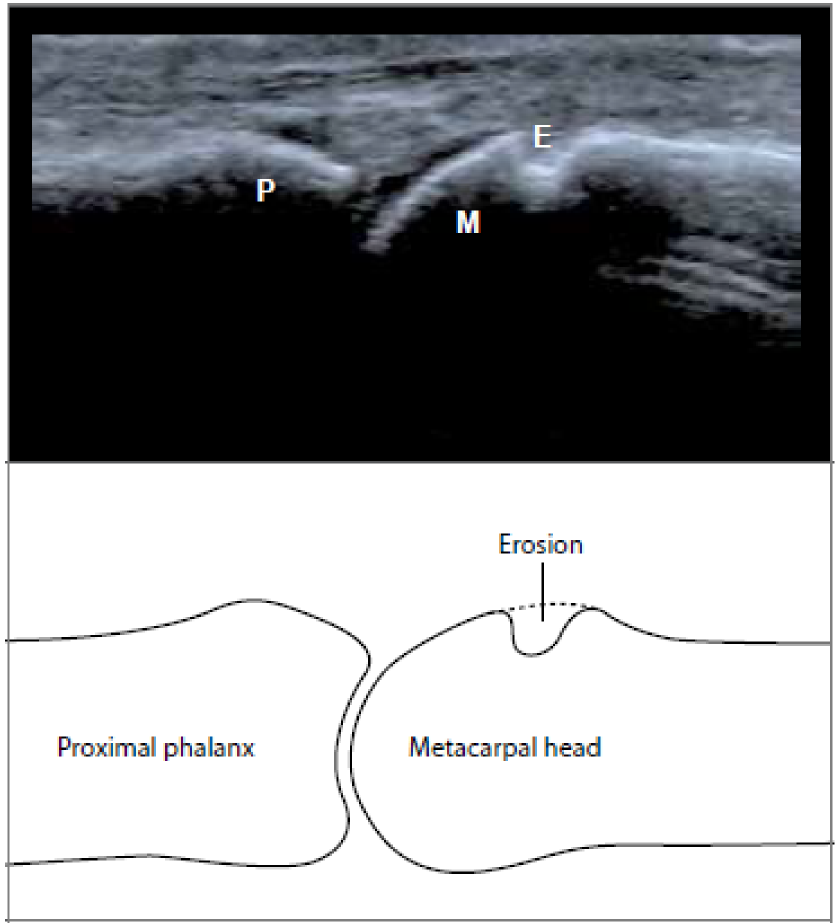
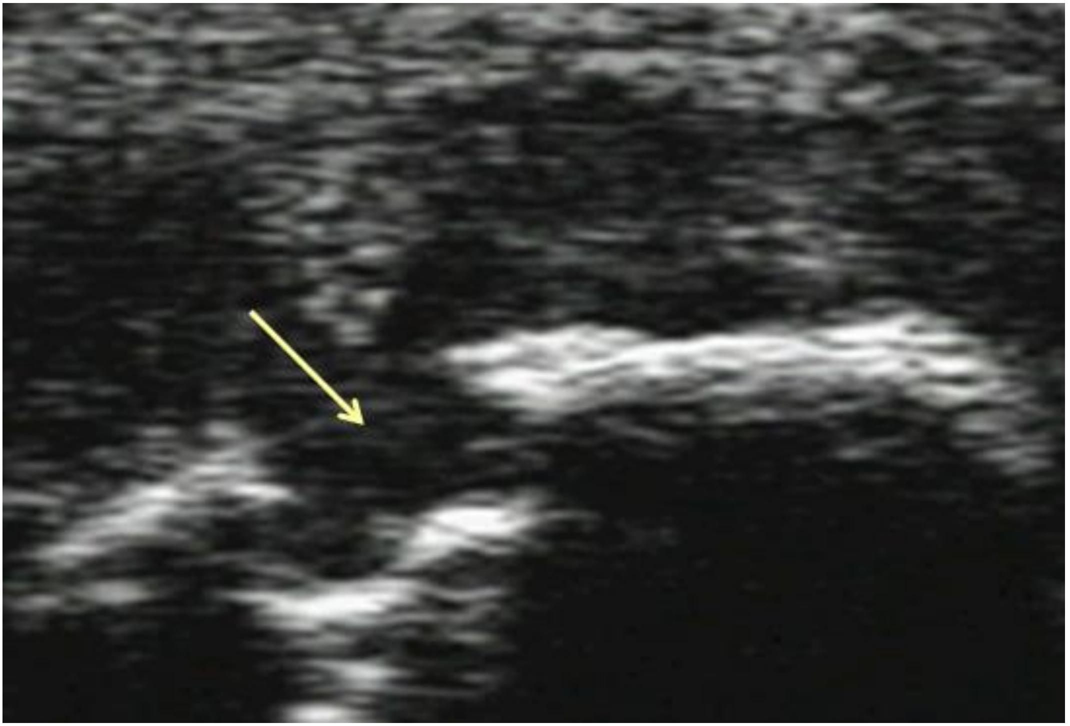


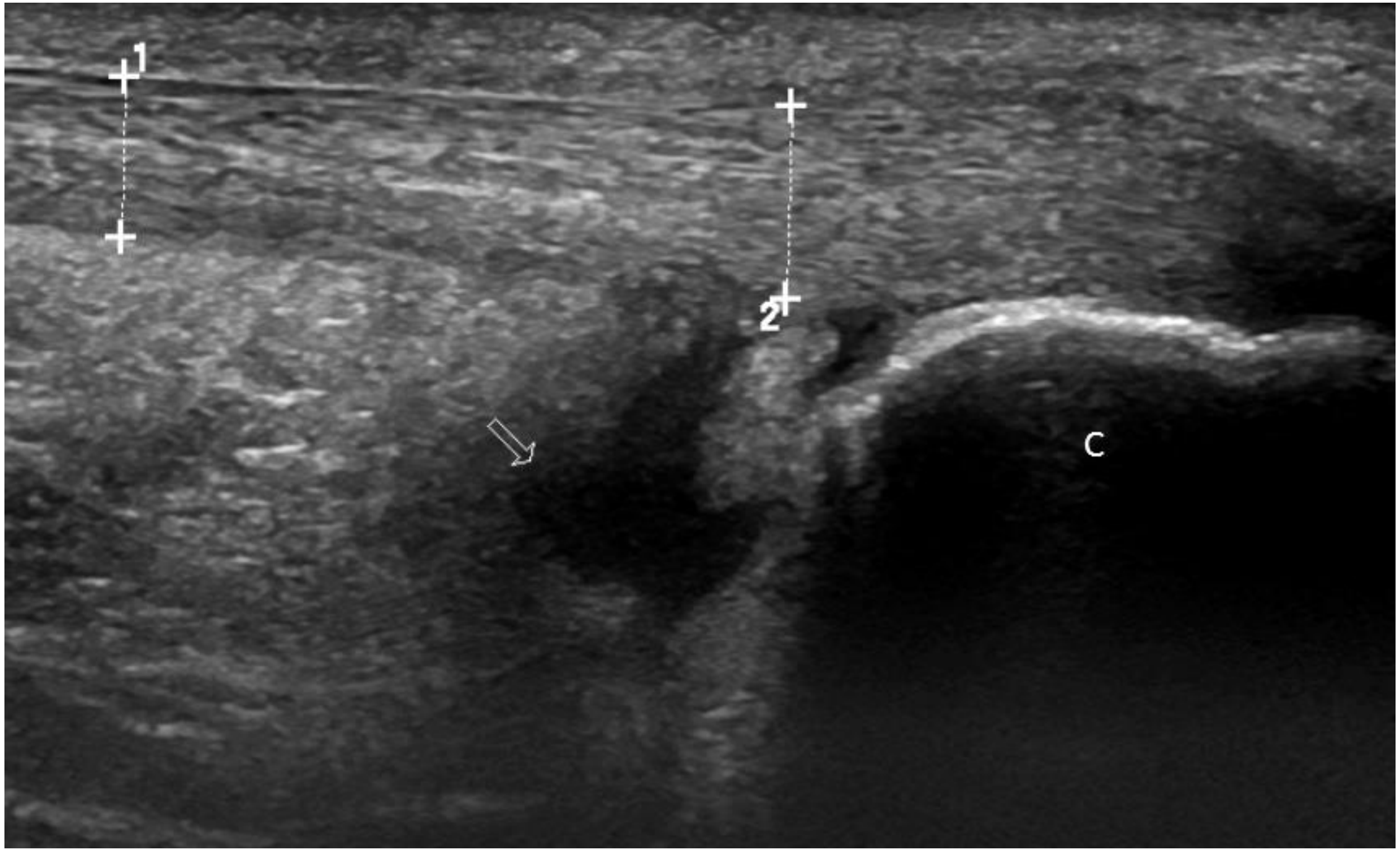
FIGURE 8. Cortical bone erosion of the 2nd metacarpophalangeal joint in rheumatoid arthritis (dorsal longitudinal scan). The erosion is sited at the anatomical neck of the metacarpal head. [E erosion; M metacarpal head; P proximal phalanx]

Erosion. Level of the erosion bottom is at a lower level than the cortex of normal bone. An erosion should be seen on longitudial and transverse image.



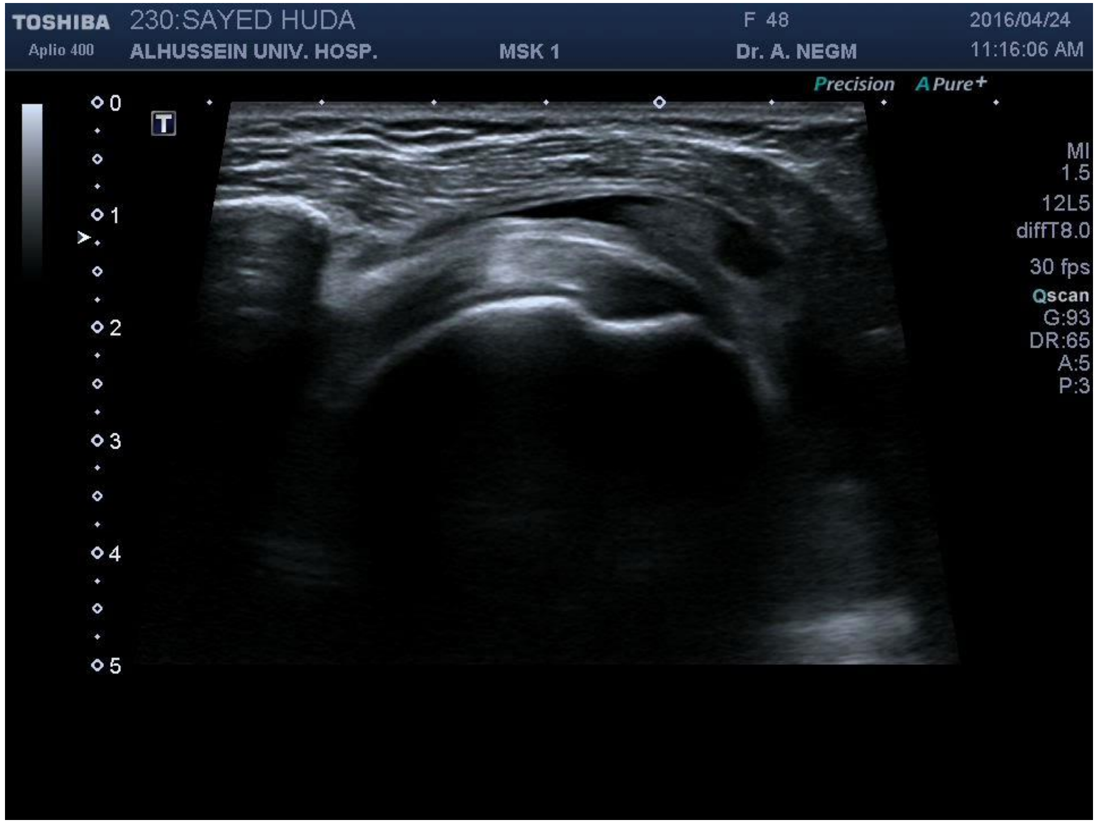
Bursae

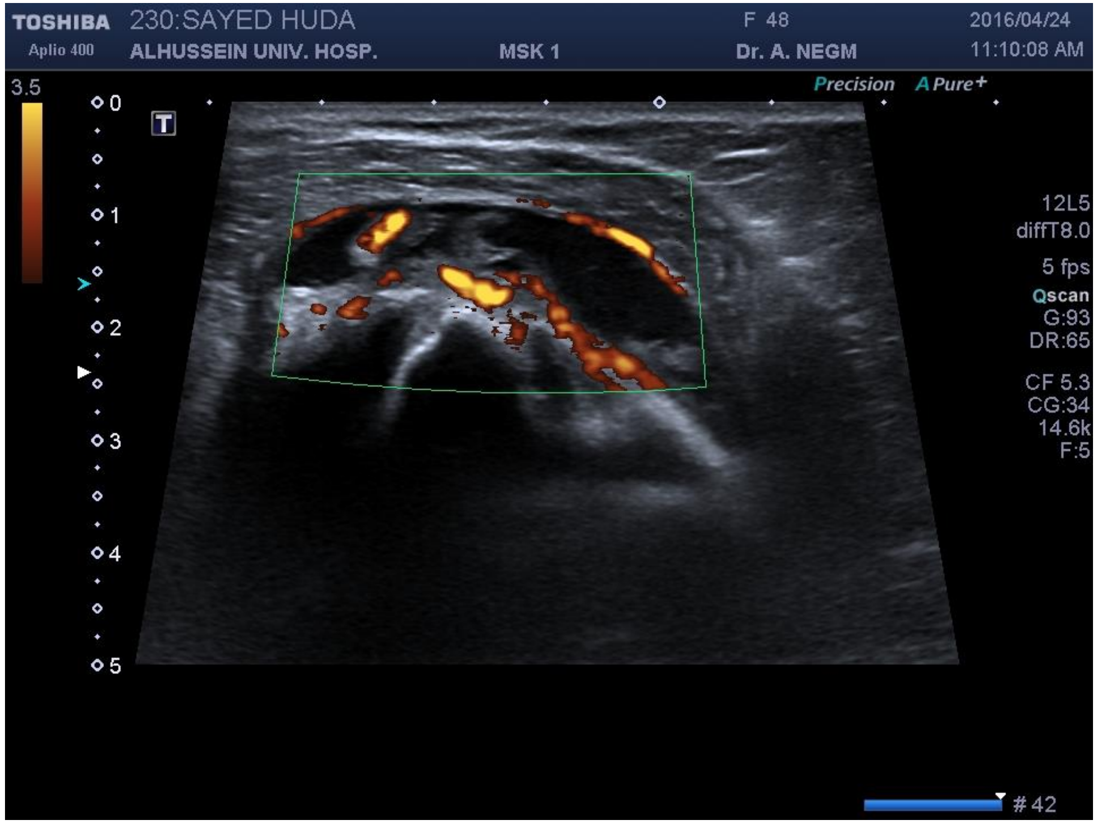
- Bursae are anechoic sacs and can only be visualized better when they become inflamed except for the Achilles bursa and the bursa at the distal insertion of the patella ligamentum that may be visualized even without inflammation



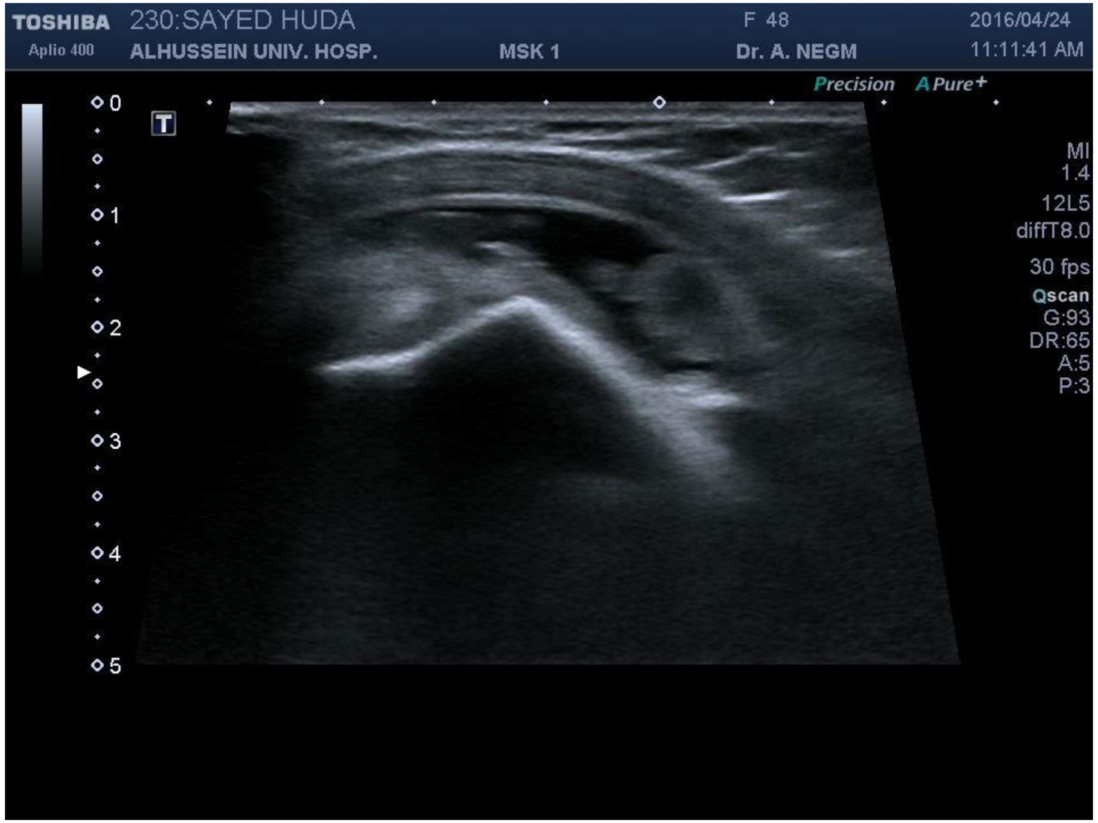
Bursitis. Longitudinal image over Achilles tendon. 1. Normal size of achilles tendon; 2. swollen achilles tendon; arrow: bursitis; C = Calcaneal bone

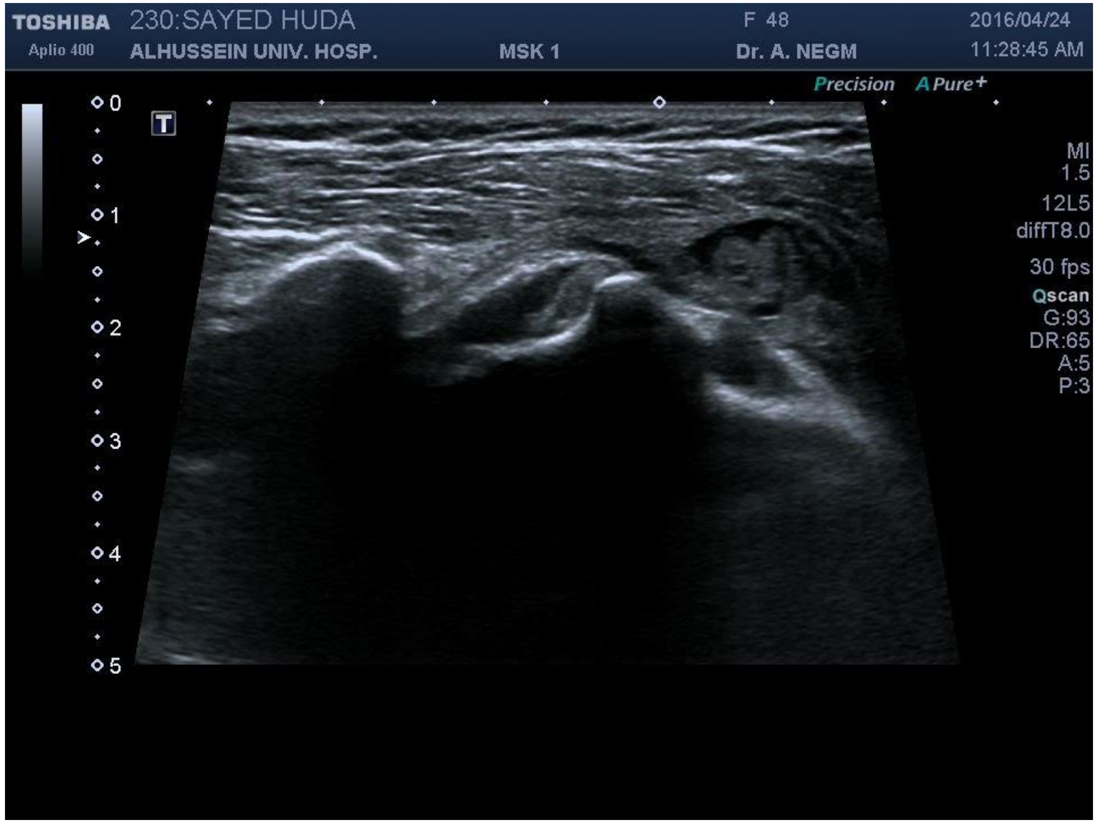
Shoulder Anterior- Subscapularis LS





Shoulder Anterior- Biceps TS





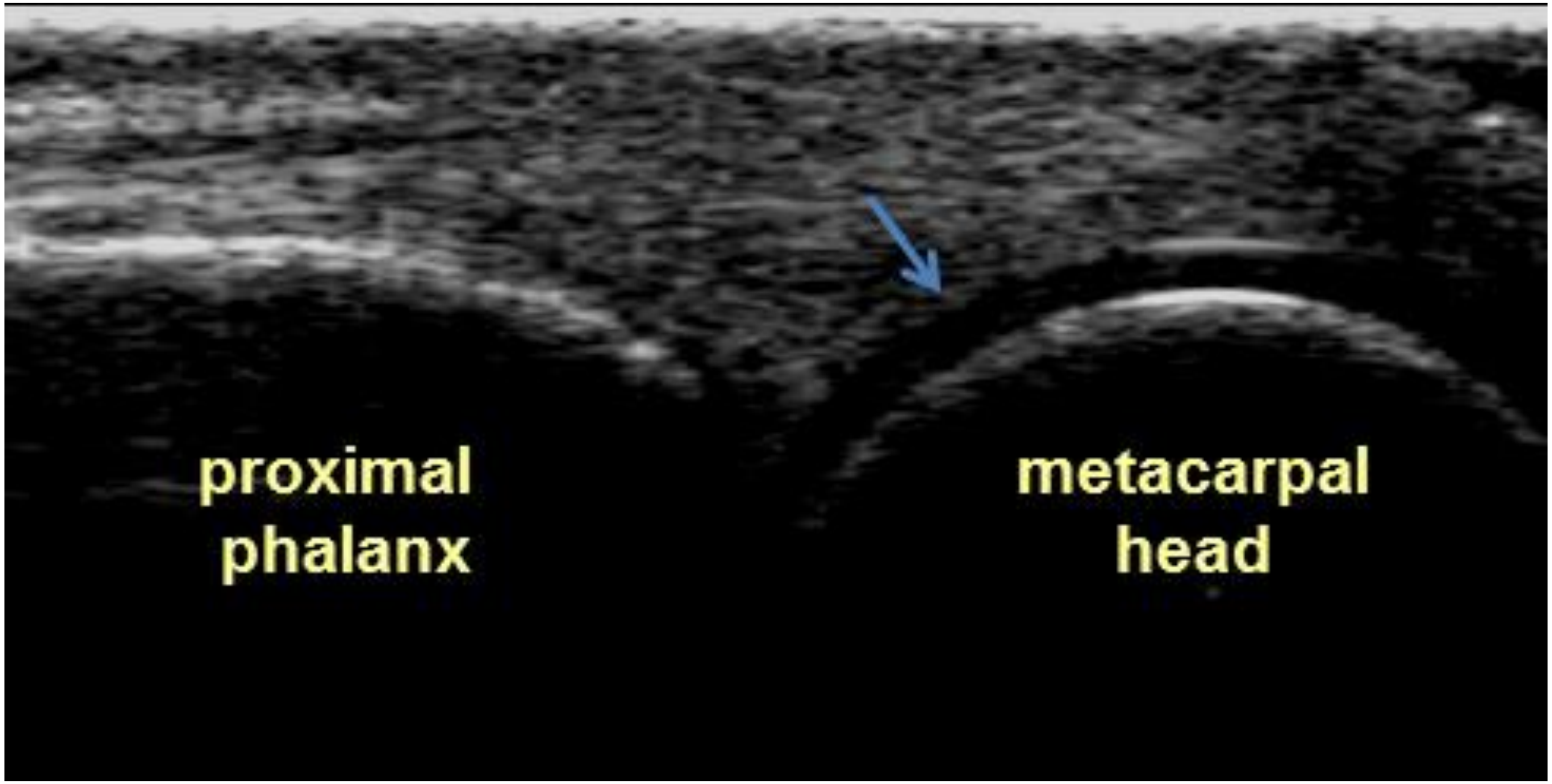
Cartilage

Hyaline articular cartilage

- Appears as a sharp anechoic layer over the hyperechoic bony cortex.
- The US image of articular cartilage depends on the amount of water in the cartilage.
- In children and young adults this hypo- or anechogenicity is higher than in elderly people, thus echogenicity tends to increase with age.

Fibro-cartilage

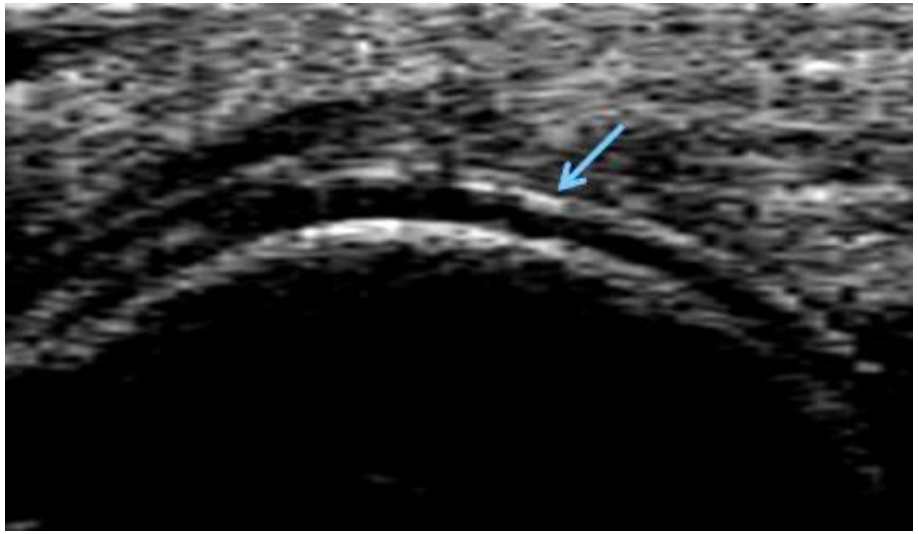
- Such as a meniscus of the knee or wrist and the labrum of the shoulder or hip, appears hyperechoic on US.
- Fibrocartilage is prone to chondrocalcinosis



Hyaline cartilage longitudinal image.
In the normal situation this cartilage is an-echoic

Loss of the normal sharpness of the synovial space-cartilage interface and loss of cartilage transparency is among the earliest signs of osteoarthritis. A later sign is marked thinning of the cartilage layer.

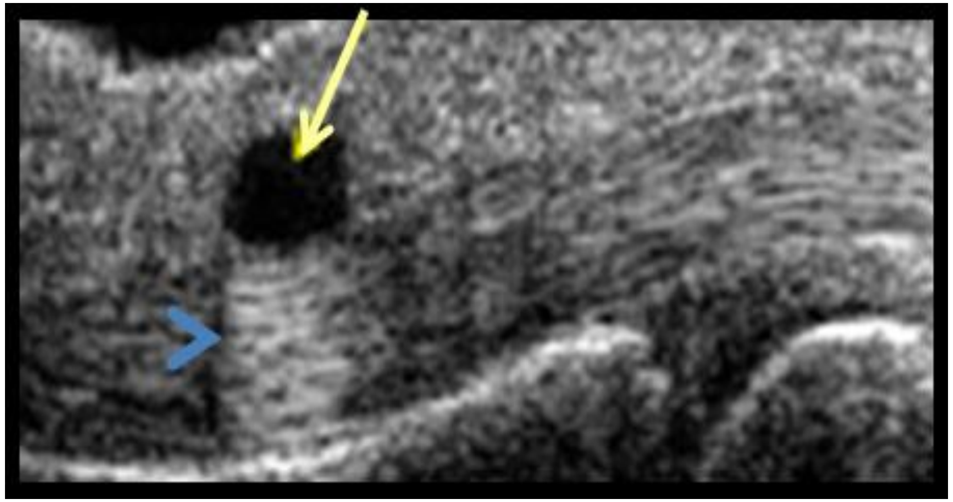
- Urate crystal deposits may be seen on the surface of the hyaline cartilage as a thin line or dots on the cartilage



Double contour (blue arrow) which means on the outside of the cartilage is a line of gout crystals seen.
This line moves with the bone.

Fluid

- Compressible and displaceable when applying transducer pressure.
- Clear fluid in a bursa or in a ganglion cyst or effusion in the case of arthritis, appears anechoic on the image

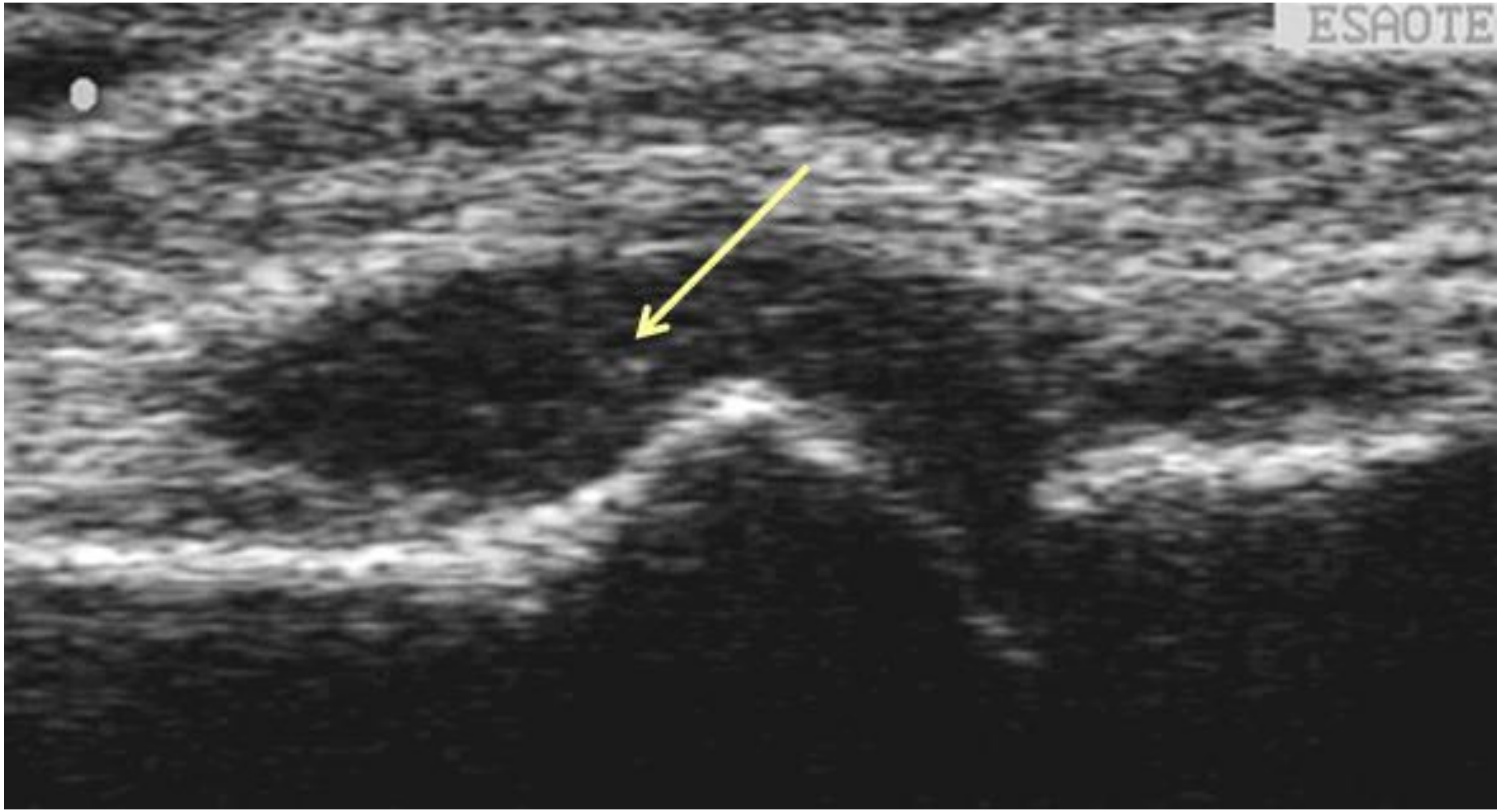


Tendon ganglion. Notice the posterior acoustic enhancement (blue arrow head) below the fluid above it (yellow arrow).

Synovium

- Synovial proliferation is hypoechoic and is non-displaceable and poorly compressible when applying transducer pressure.

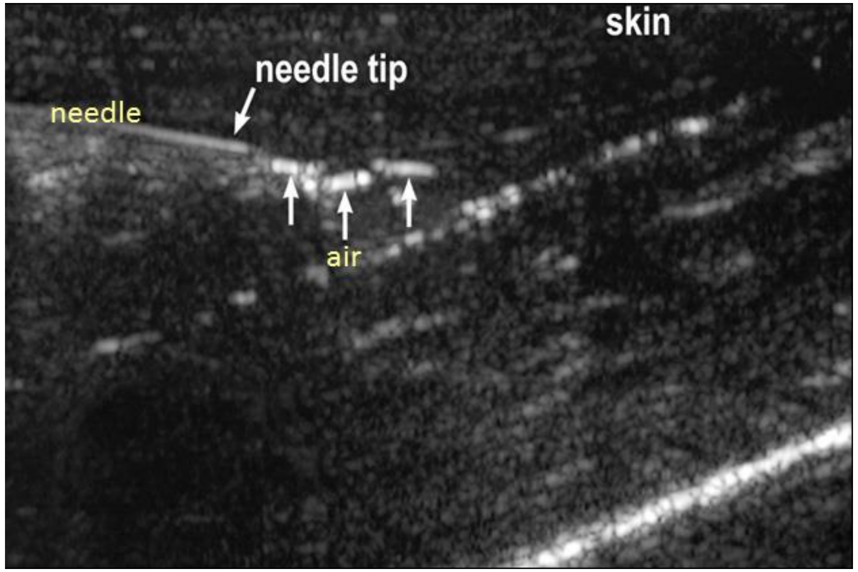
- Normally the synovial lining cannot be seen on the image, however, in the case of arthritis or tenosynovitis, synovial proliferation and/or synovial fluid can be seen.
- Changes in synovial hypertrophy can be seen after therapy



Synovial proliferation . Arthritis with mainly synovial proliferation (see arrow) in MTP1.

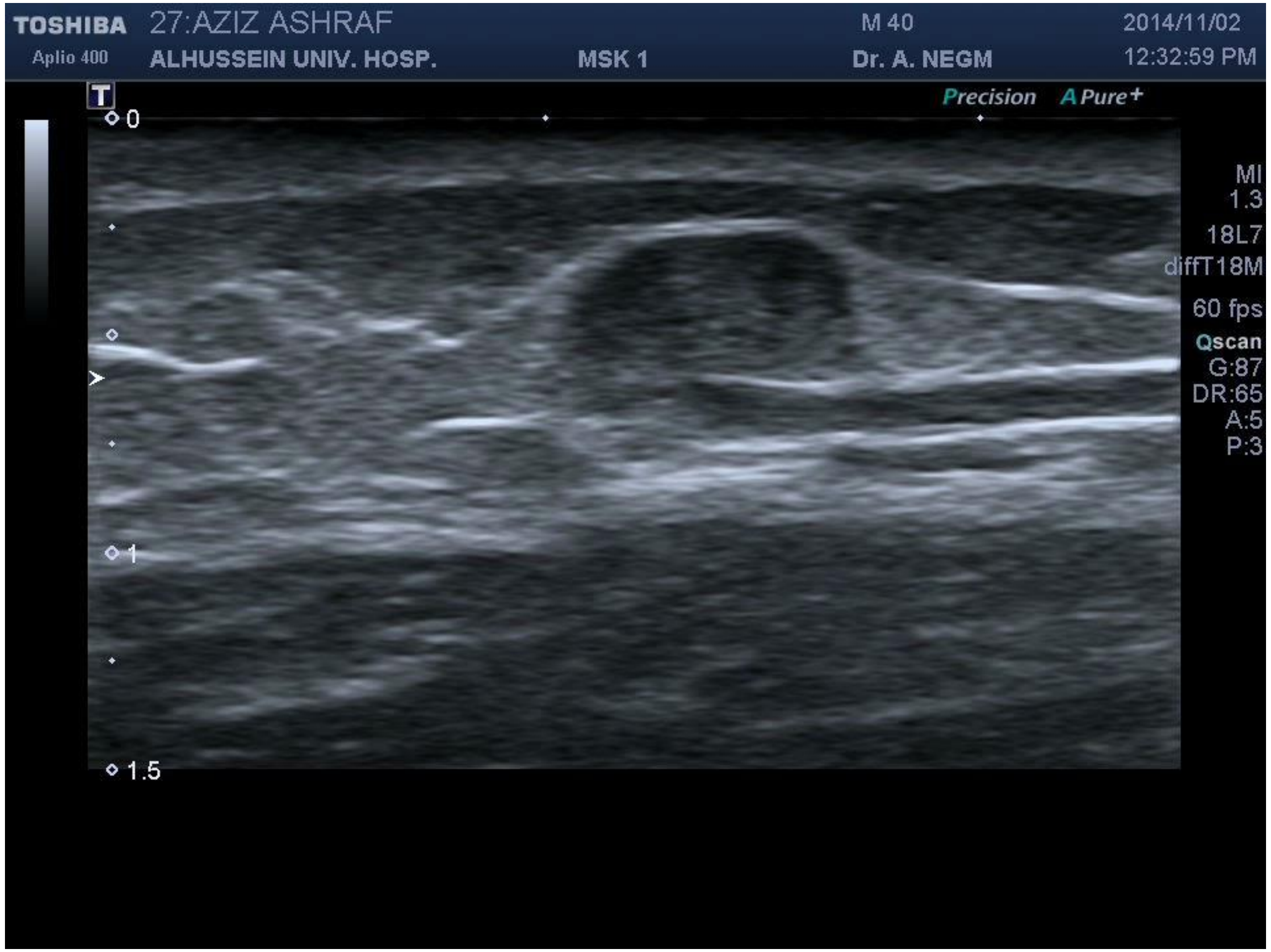
Gas

- Gas (e.g. air) can be seen on a sonogram as bright hyperechoic echoes sometimes with posterior reverberation artifacts.

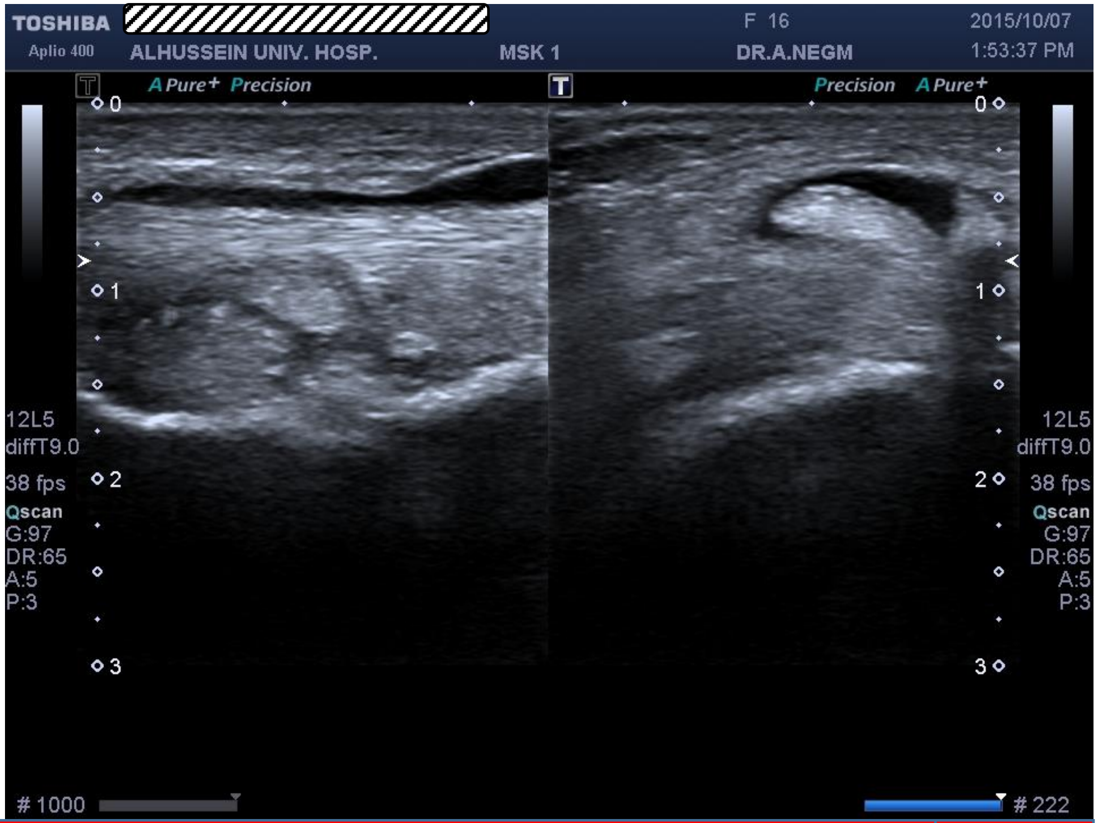


Air injected in chicken meat; experimental setting for educational purposes.Note the strong reflections of the air

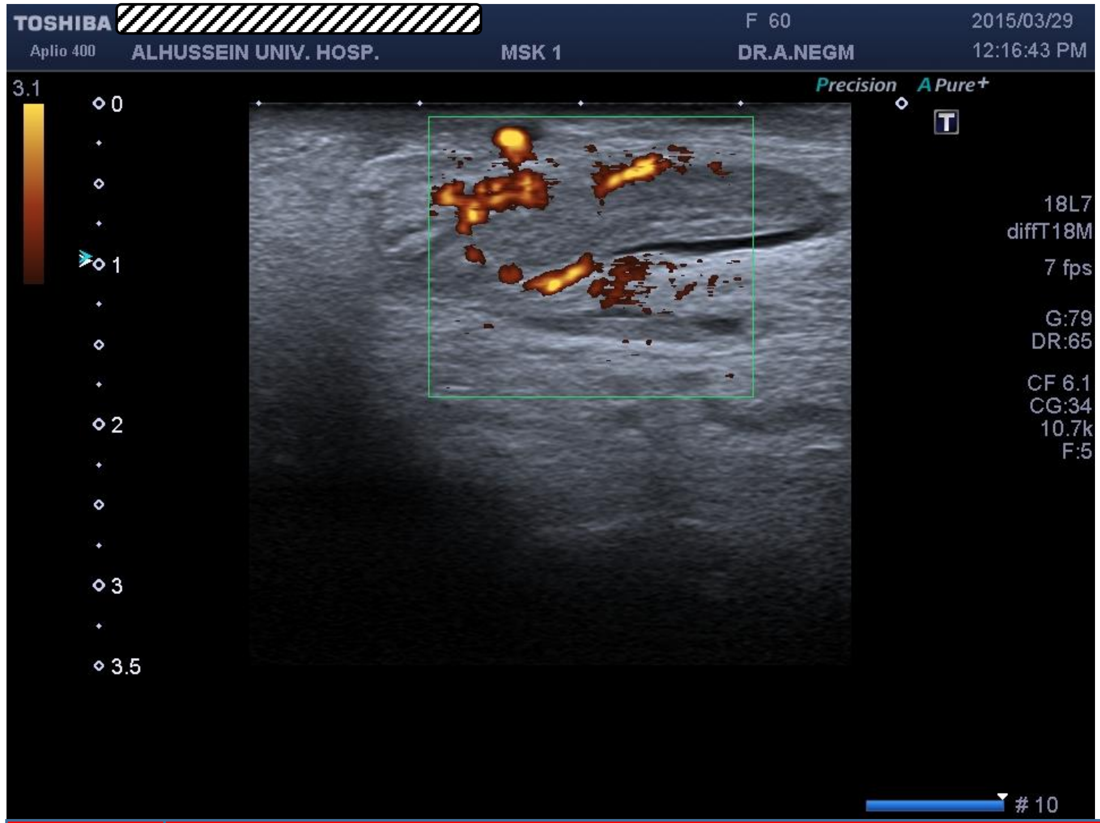
Color Vs Power Doppler



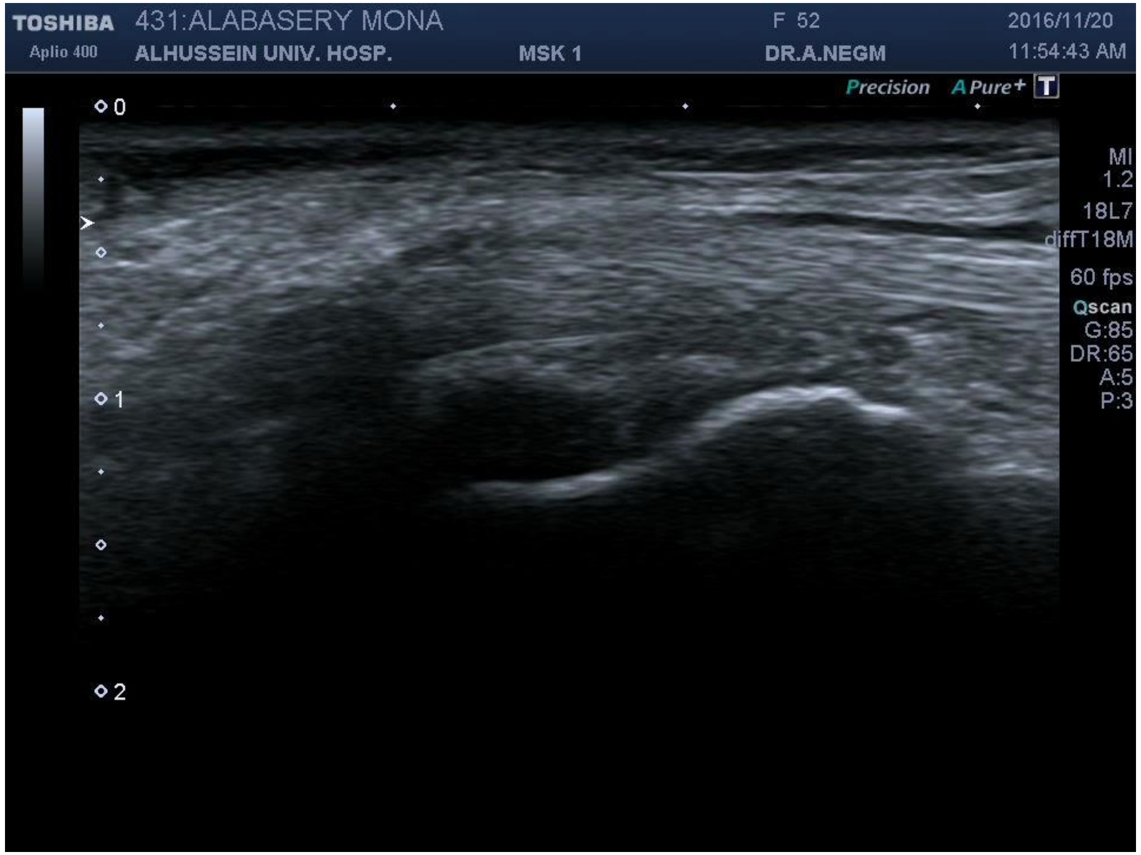
Posterior Tibialis Tendon



Case 1: LS and TS if Tibialis Post. Tendon showing anechoic effusion of the tendon sheath



Case 2: TS if Tibialis Post. Tendon showing mild anechoic effusion and Hypertrohy as well as Power Doppler Signal of the tendon sheath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Aplio 400
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ALHUSSEIN UNIV. HOSP.
MSK 1
F 52
DR.A.NEGM
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11:54:43 AM
Precision
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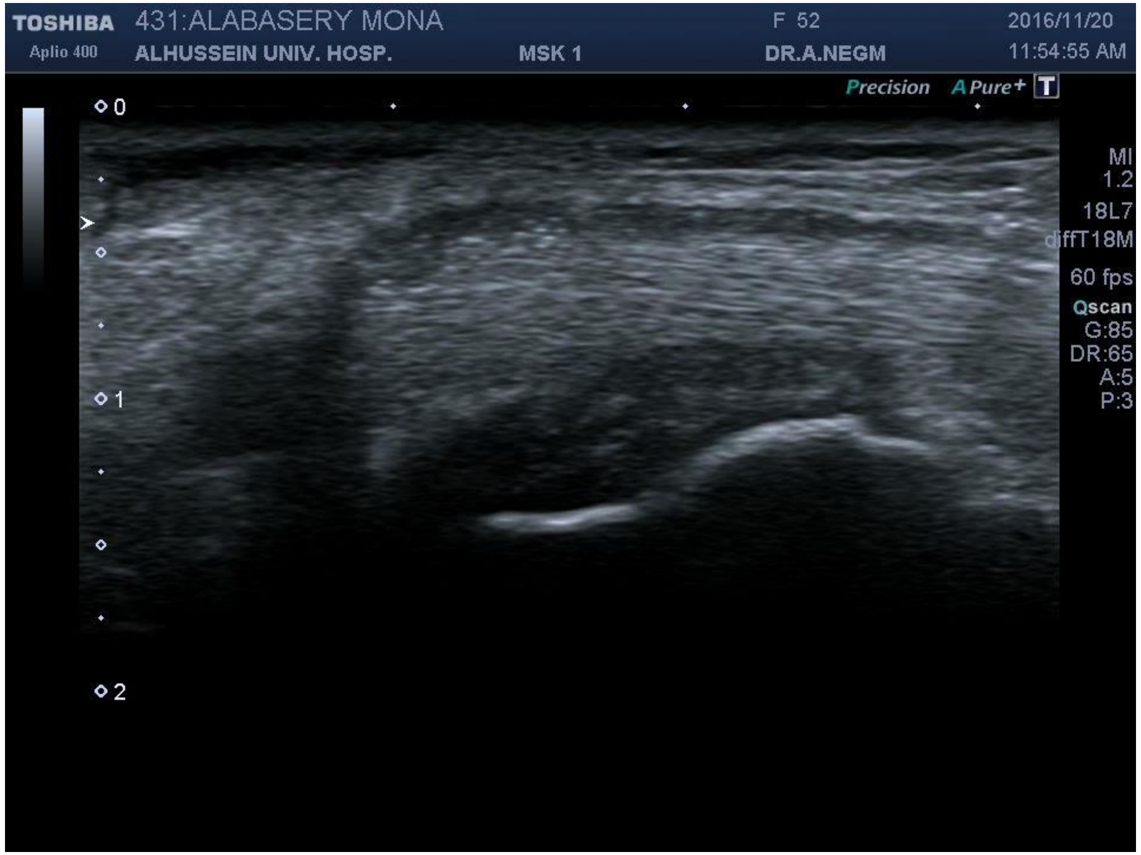
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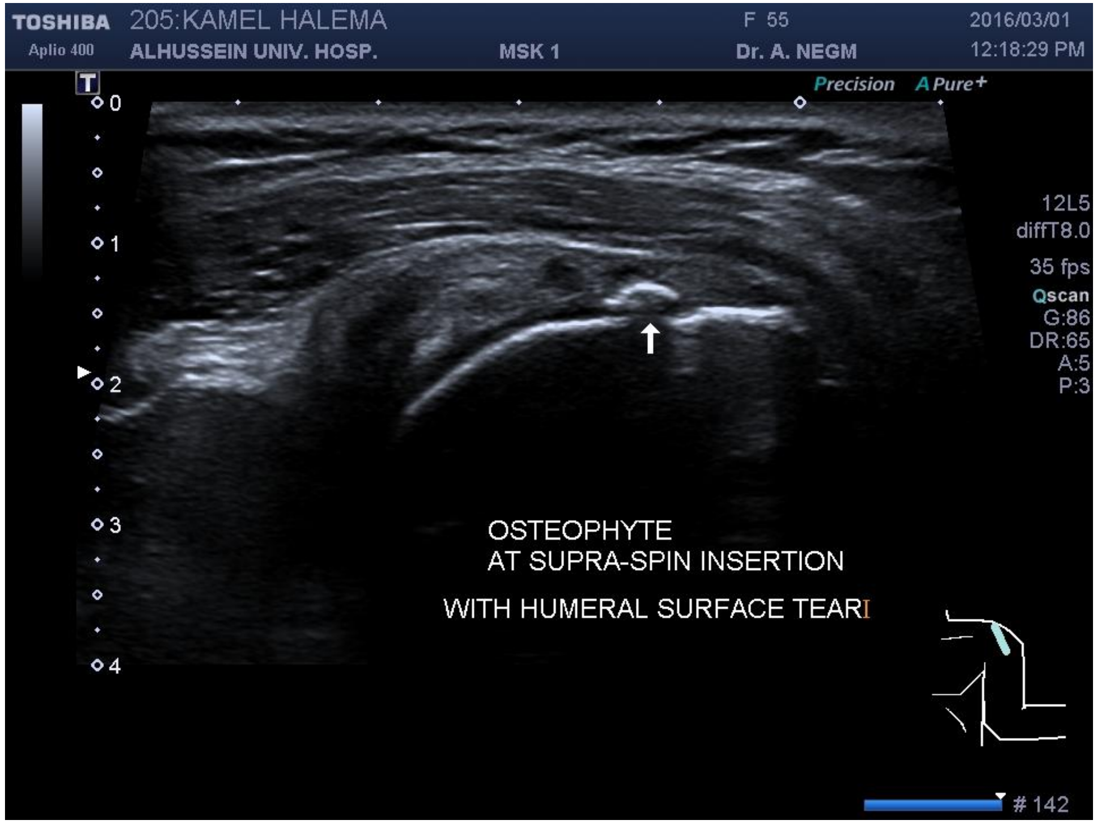
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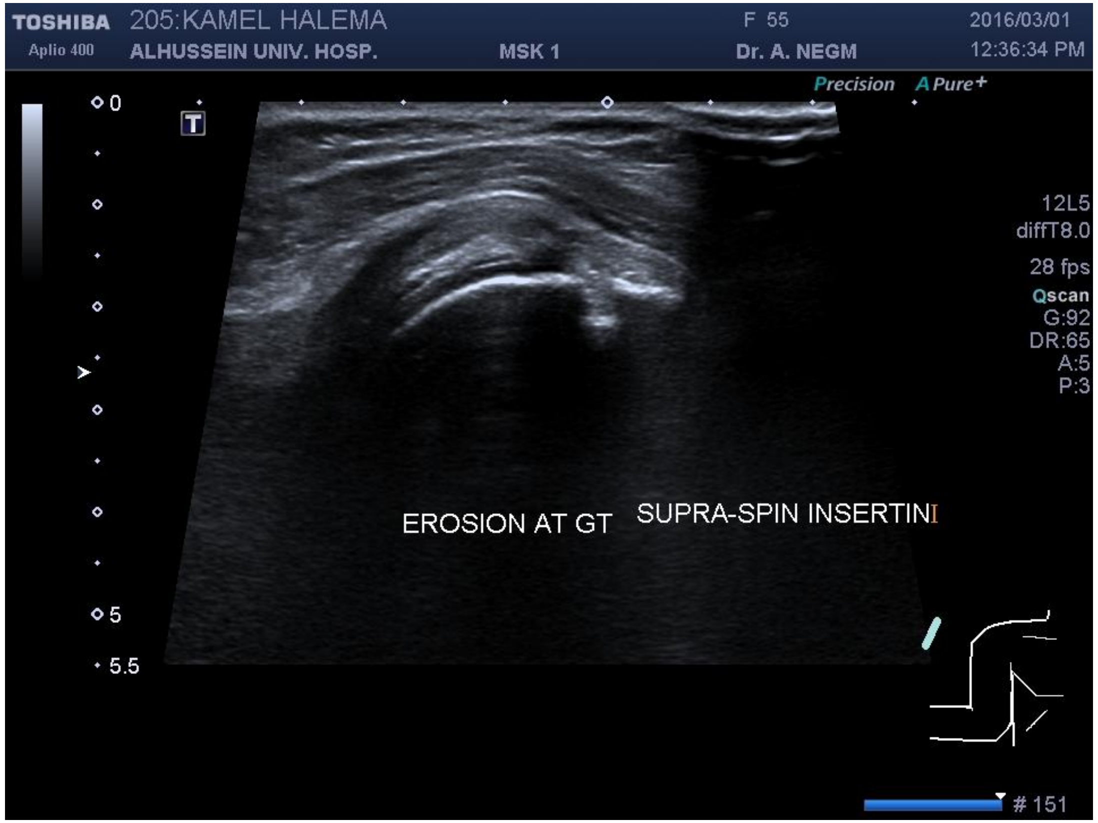
OSTEOPHYTE
AT SUPRA-SPIN INSERTION
WITH HUMERAL SURFACE TEAR
# 142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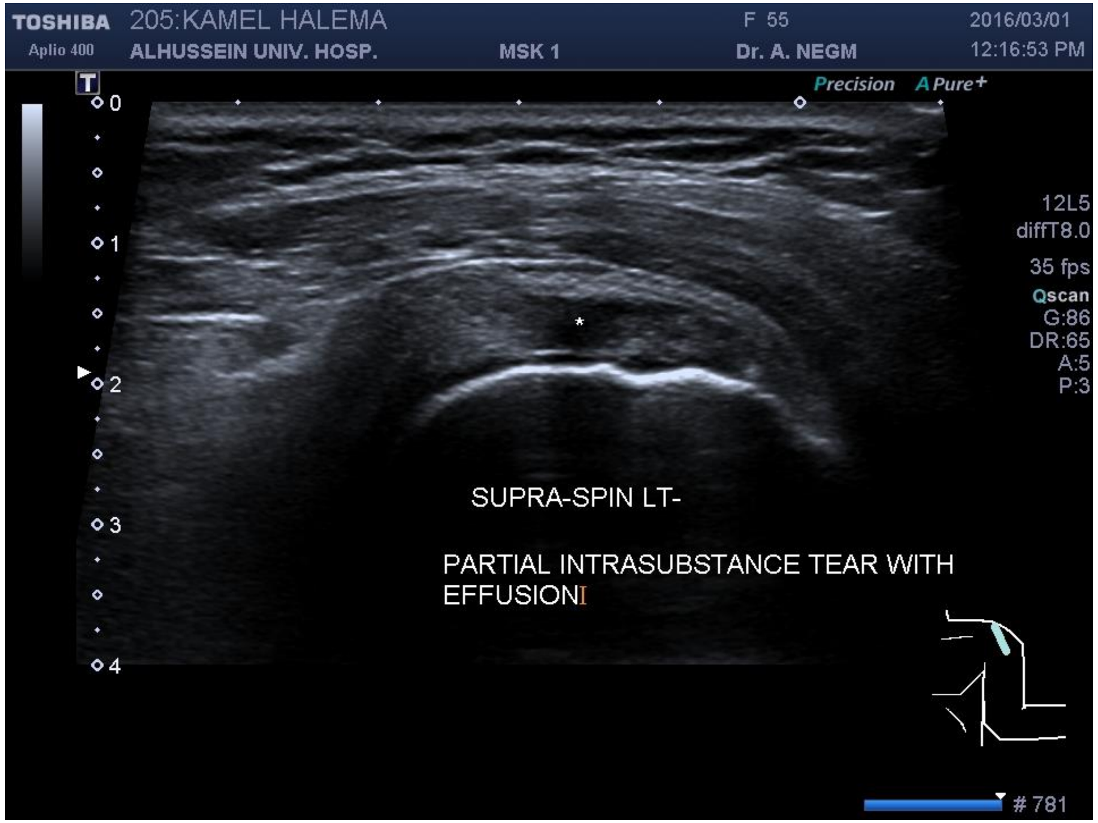
SUPRA-SPIN INSERTIN
# 151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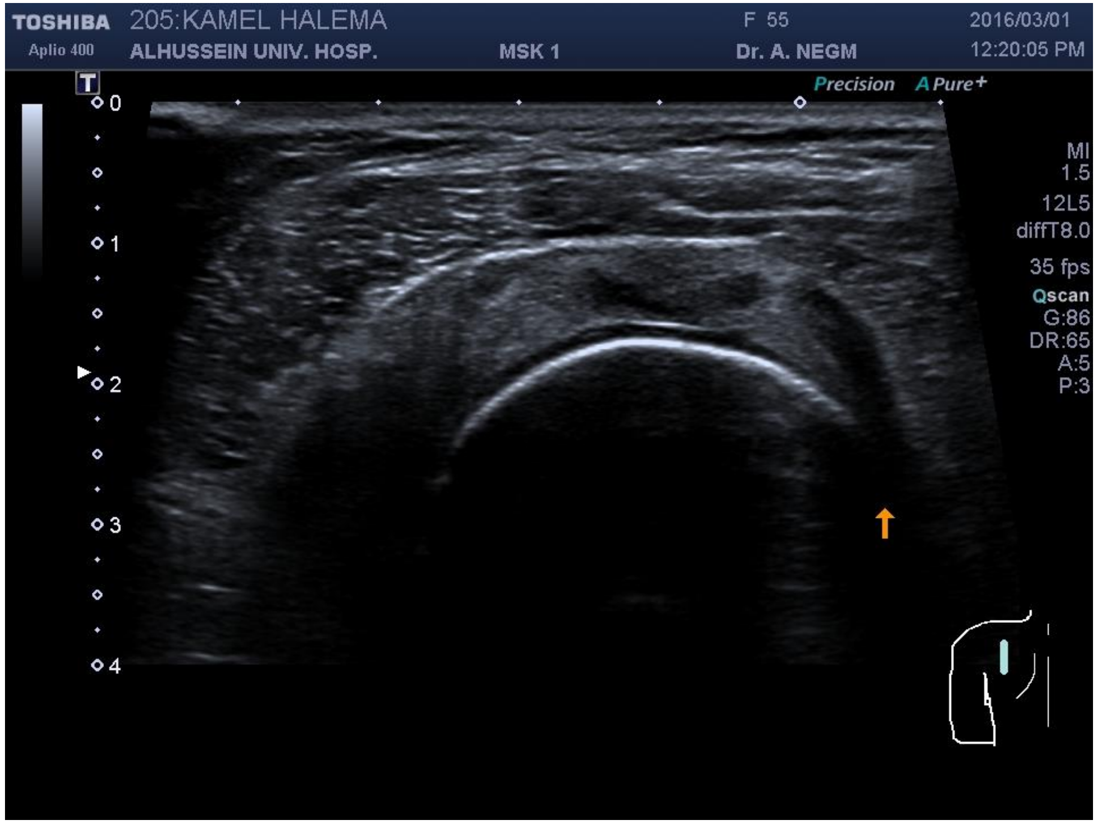
SUPRA-SPIN LT-
PARTIAL INTRASUBSTANCE TEAR WITH EFFUSION
# 781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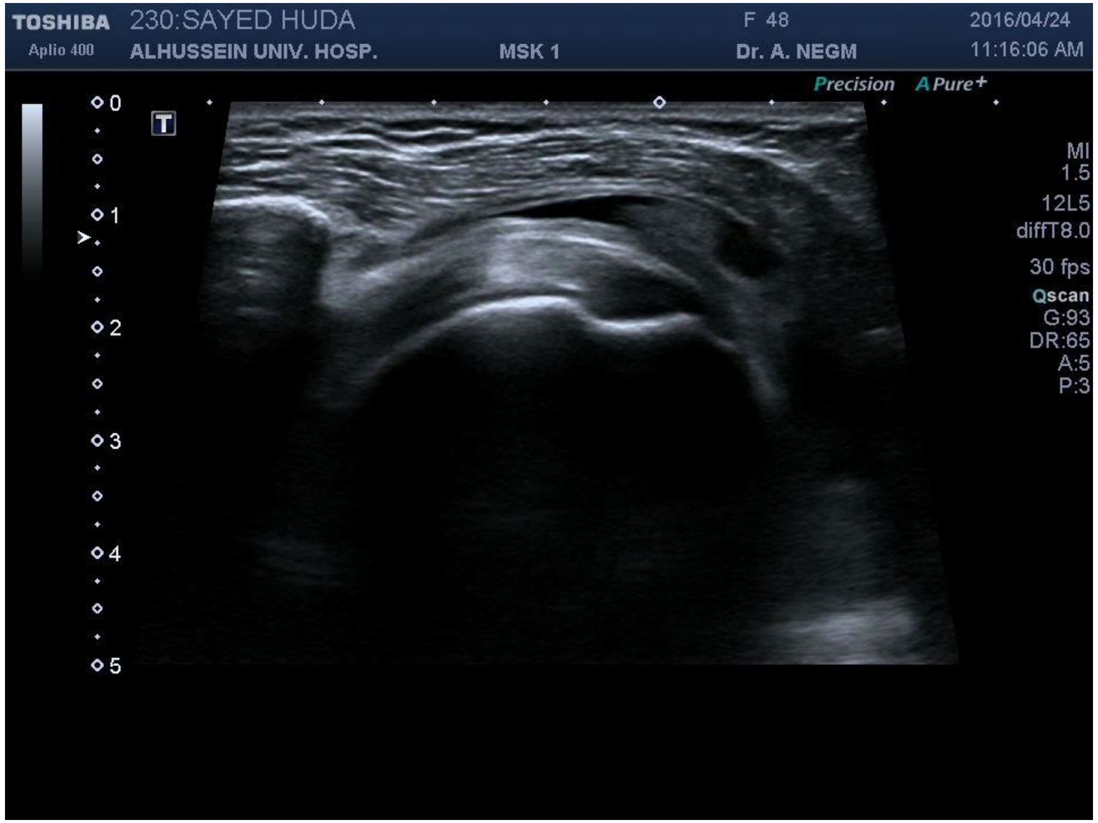
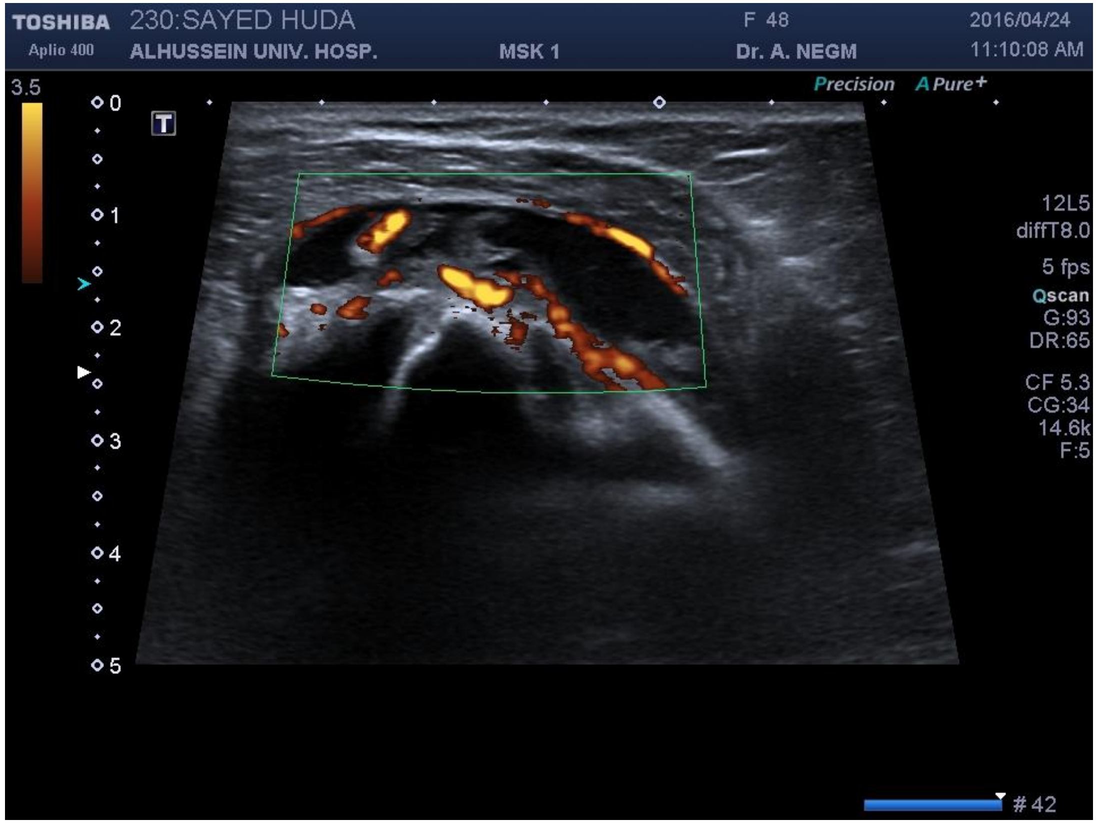
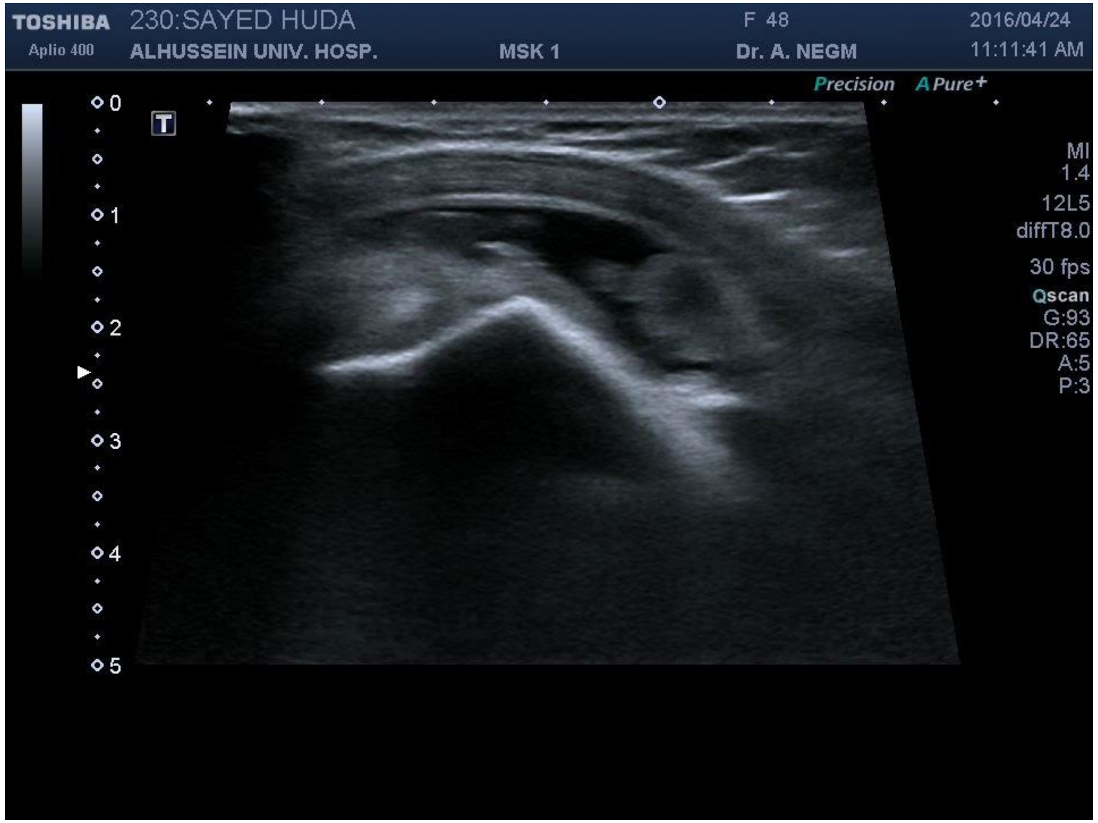
P:3

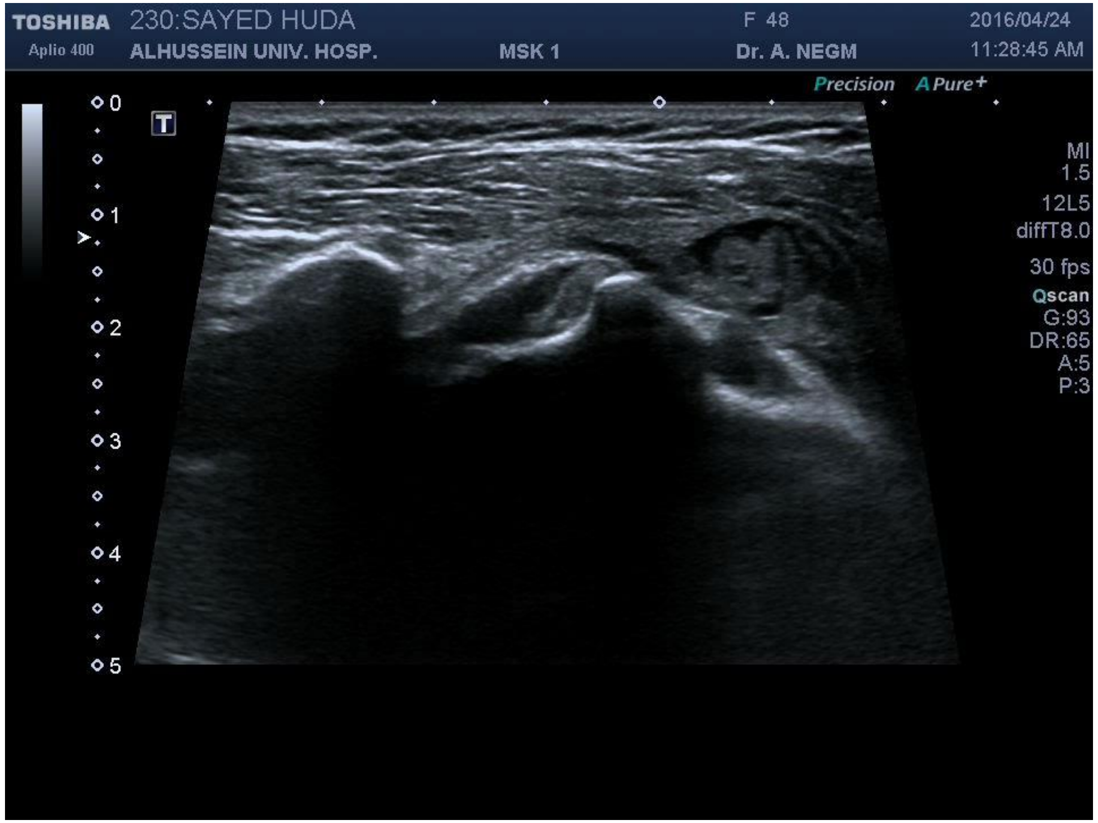
Shoulder Anterior- Subscapularis LS





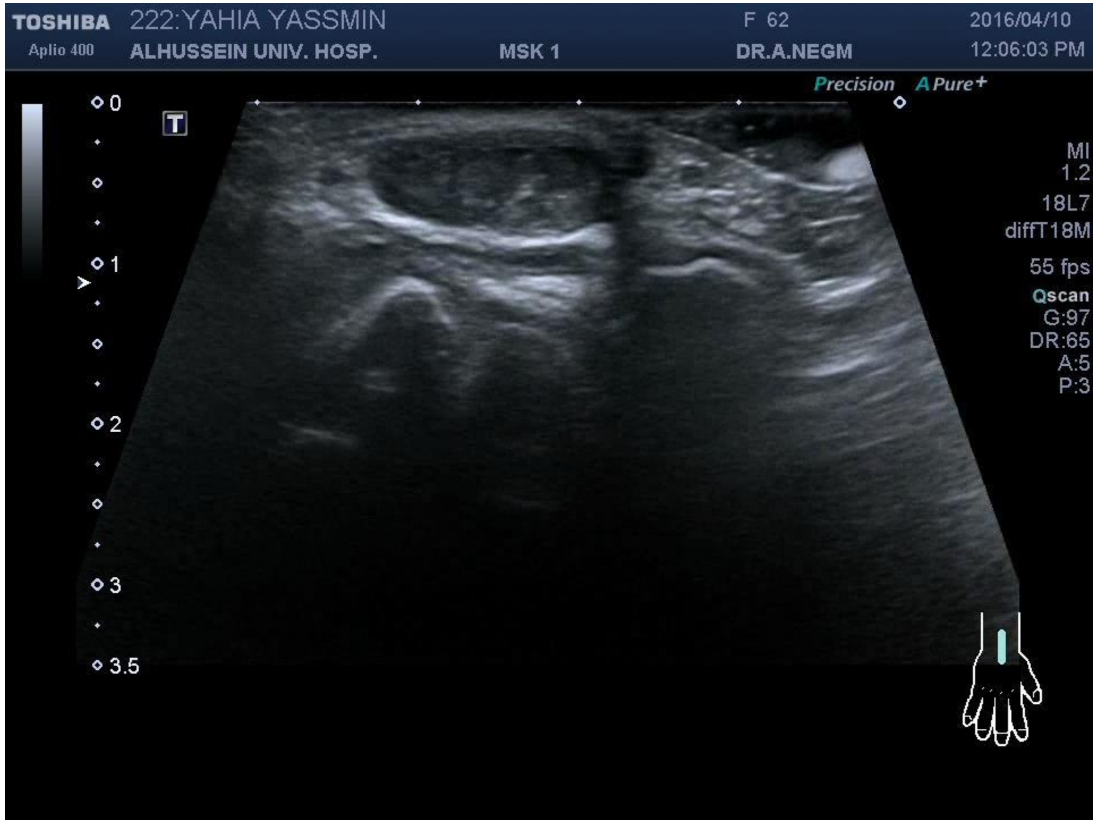
Shoulder Anterior- Biceps TS

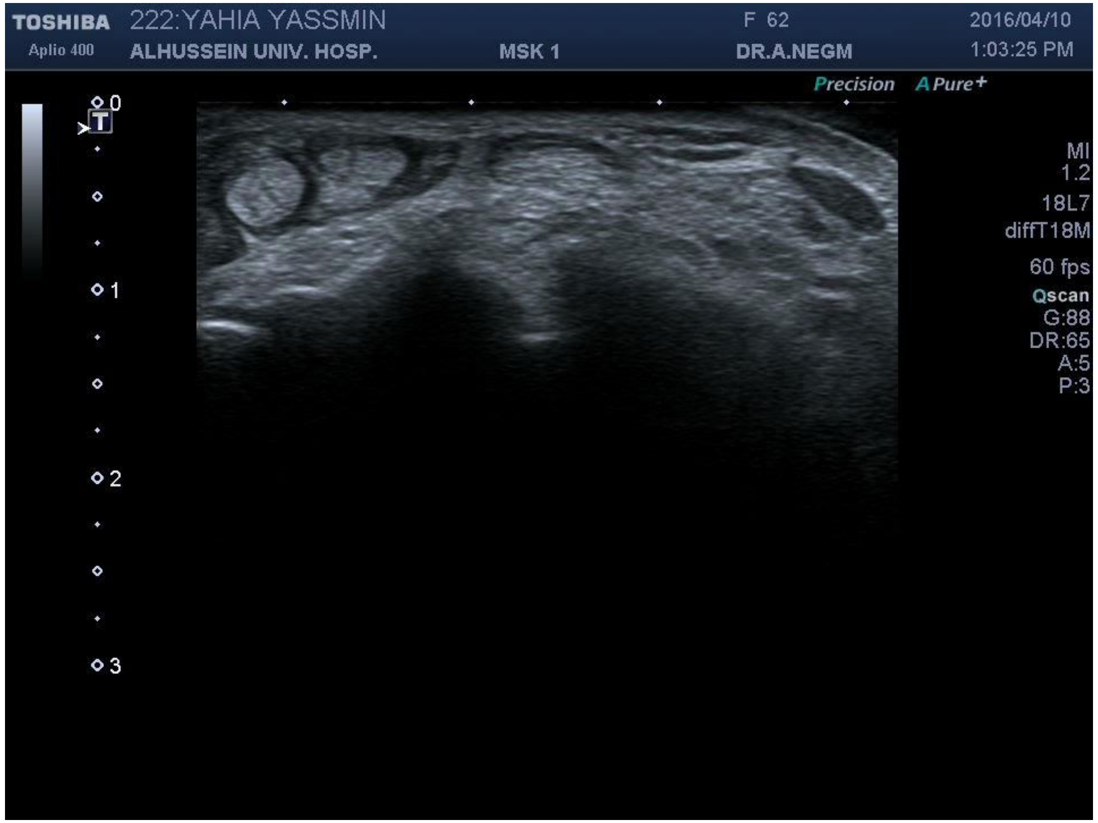




Dorsal Wrist TS- Tenosynovitis

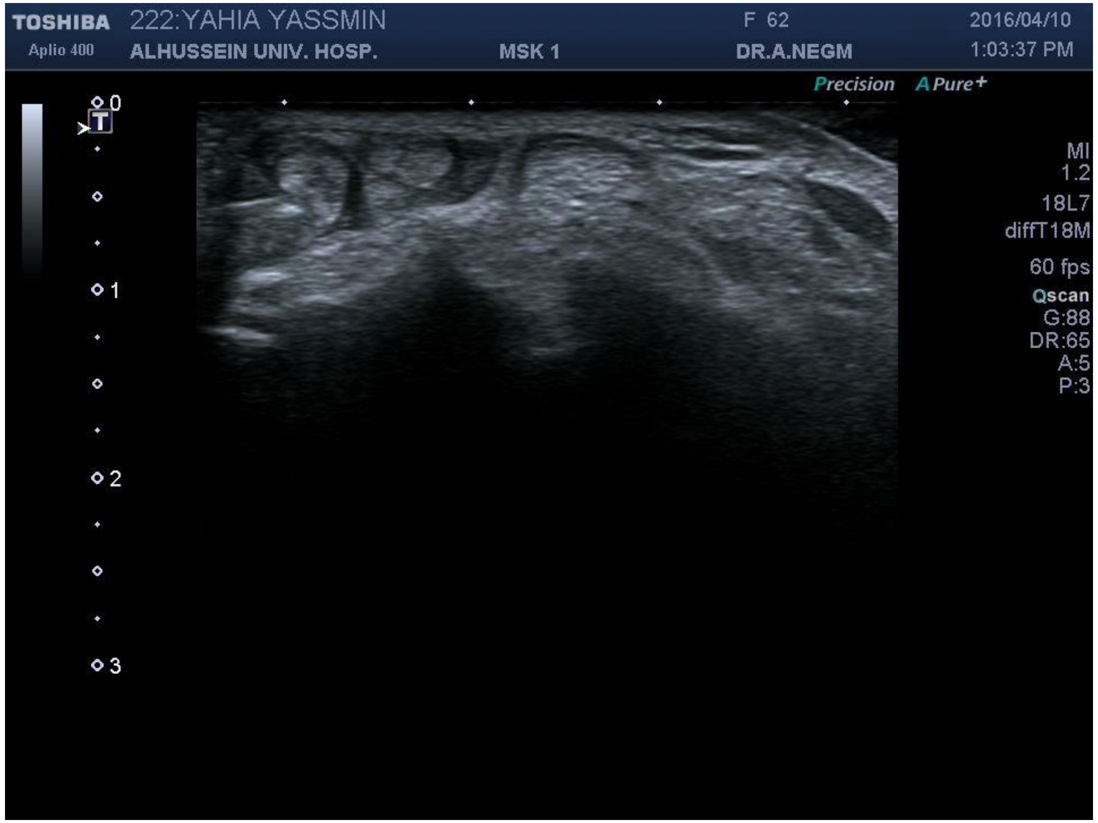
Detection- needle insertion

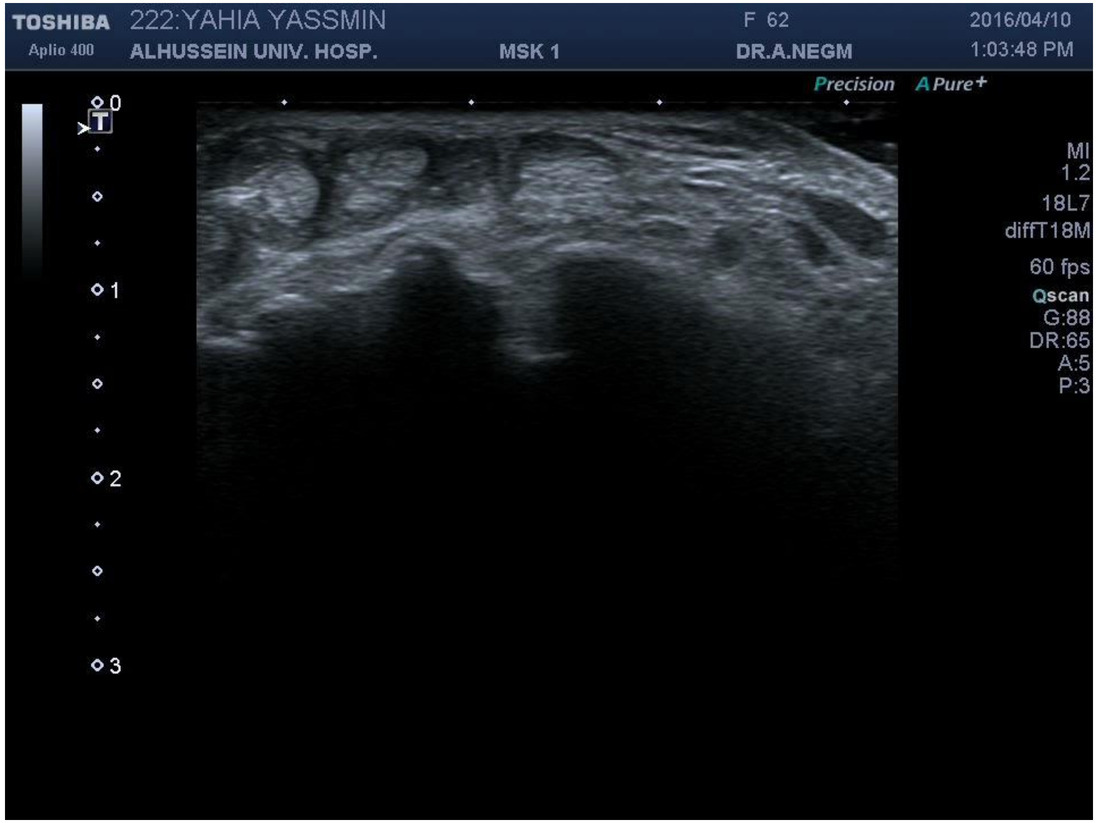




Dorsal Wrist TS- Tenosynovitis

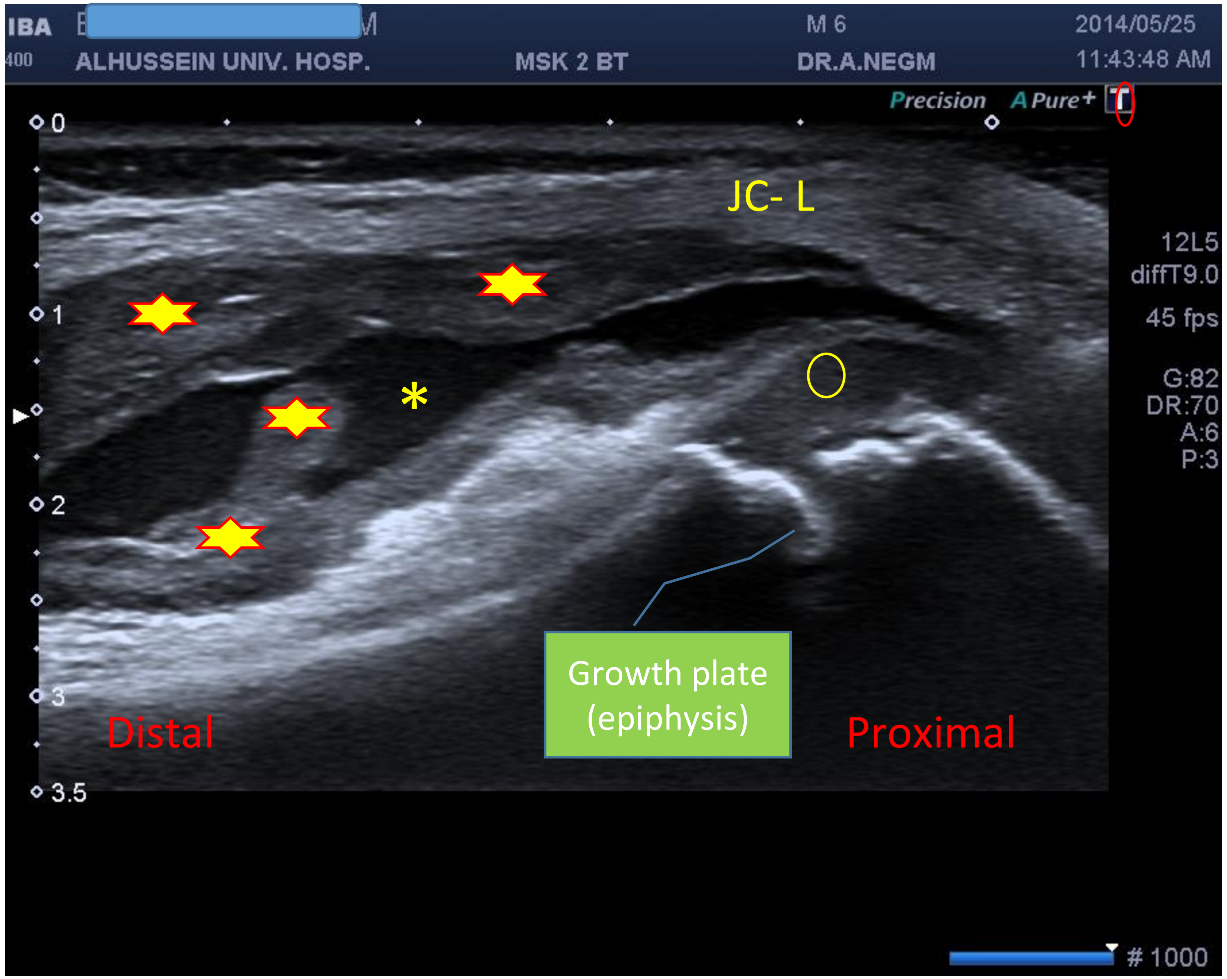
Repositioning- injection



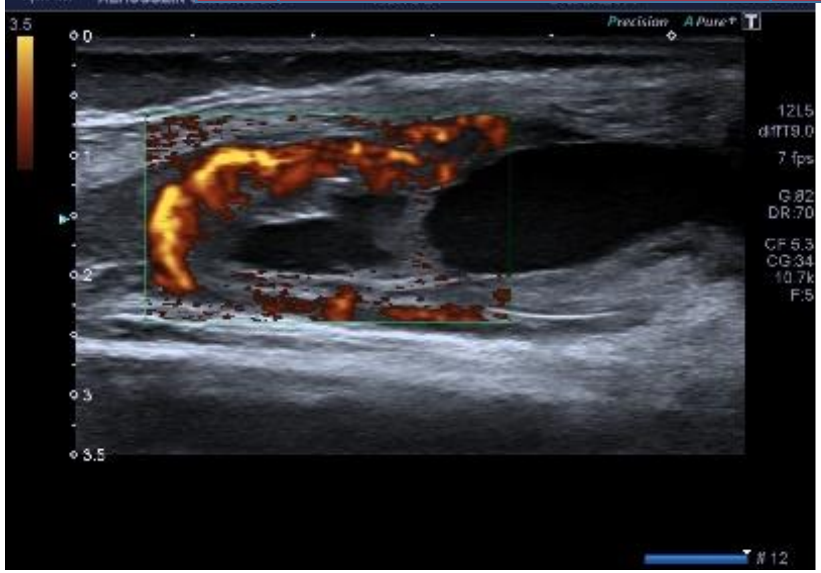


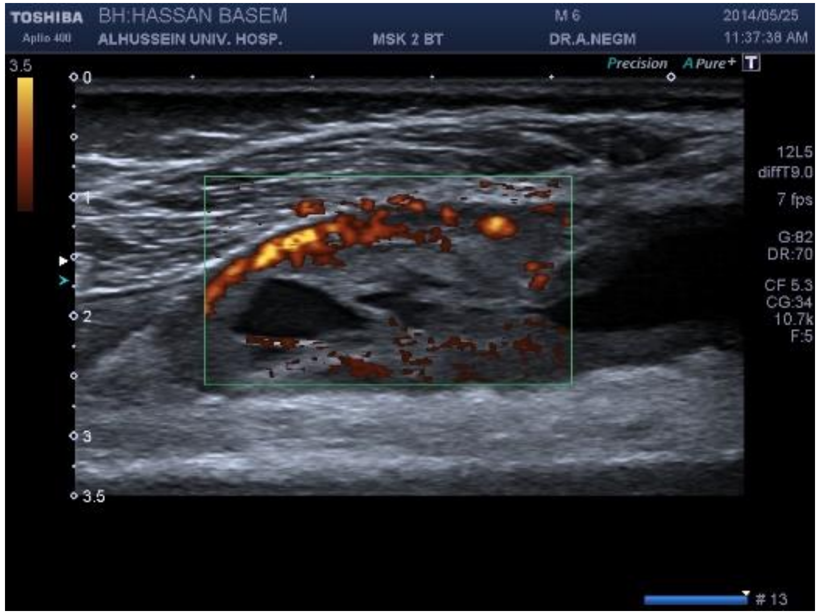
Hip

Joint effusion, Synovial Hypertroh and PD: Septic arthritis in 6 month infant

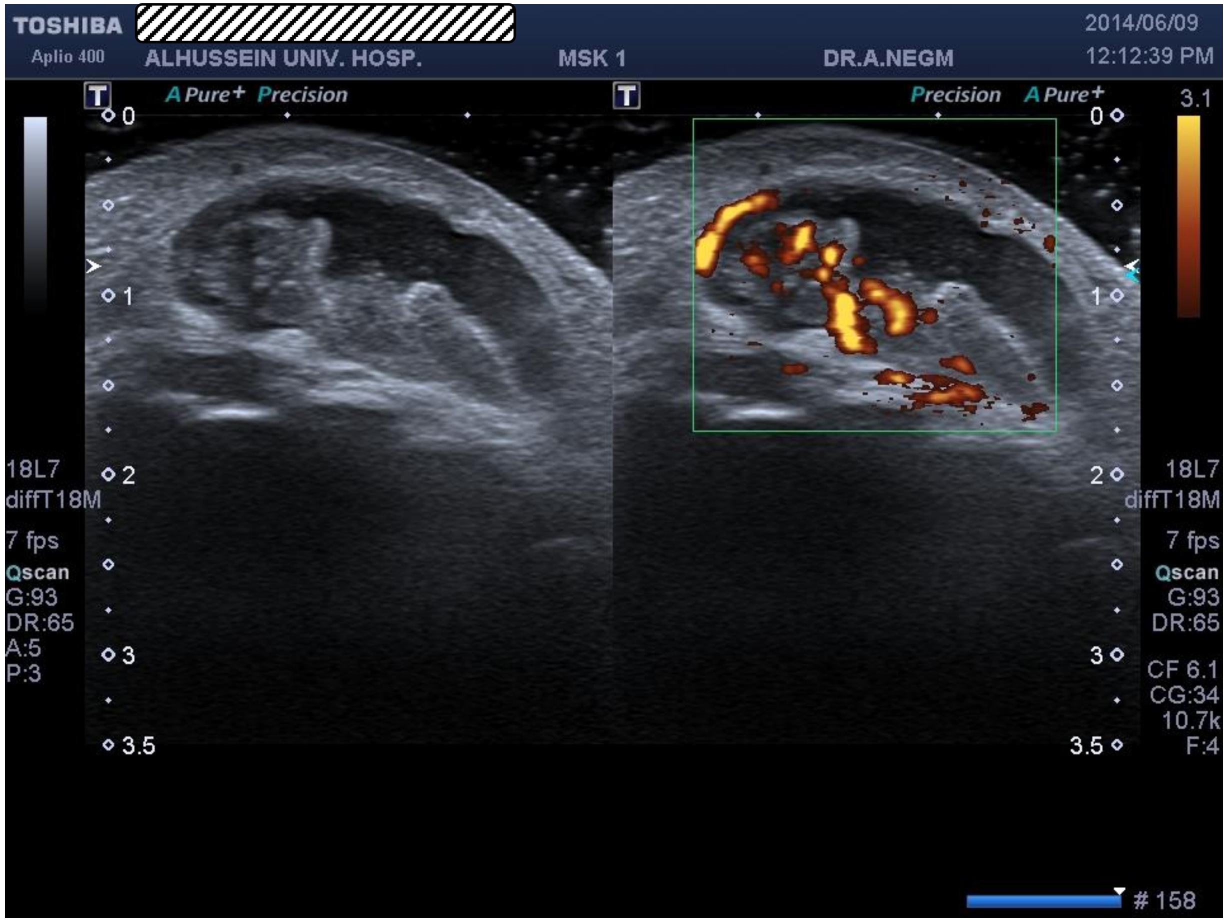


JC-L; joint capsule and iliofemoral ligament. *; indicate fluid effusion; O; hyaline Cartilage. The Stars indicate synovial hypertrophy which give severe PD signal in the small image. Gain 92; Frequency: 9 MHZ (infant), Probe: Linear5-12 MHZ



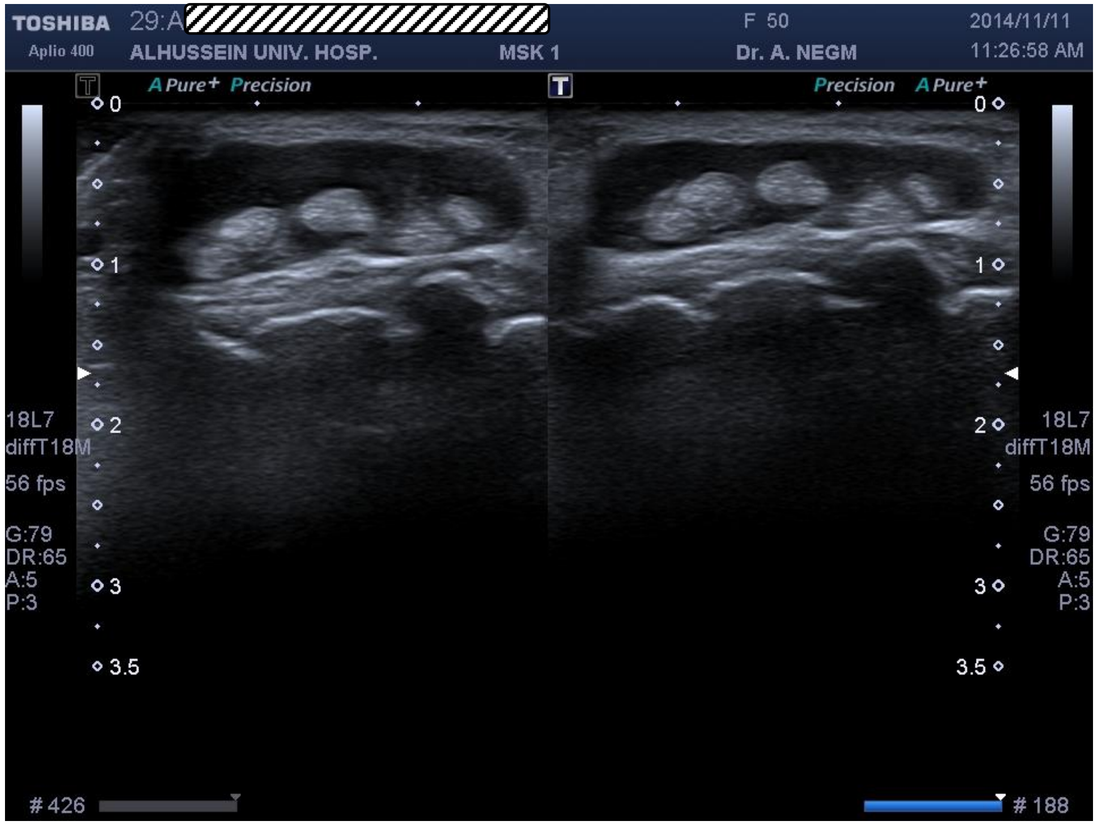


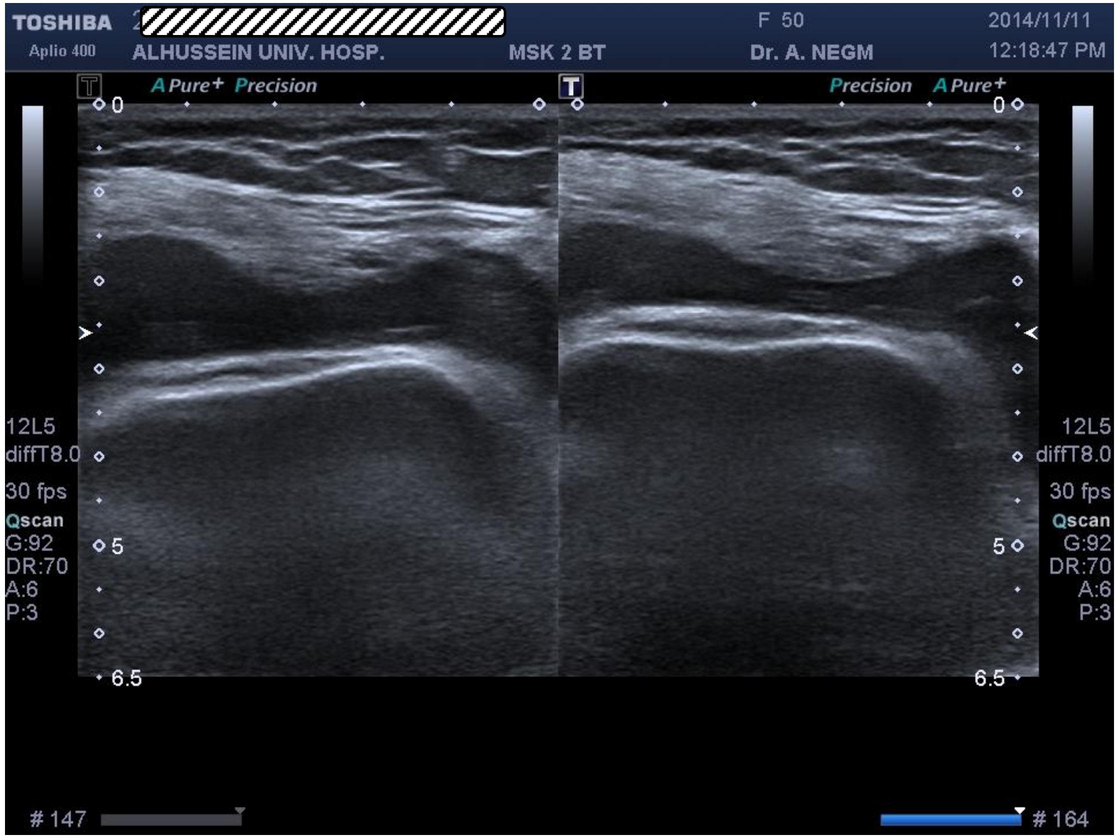
TS over extensor tendons
(Effusion, Synovial Hypertrophy & Synovitis)



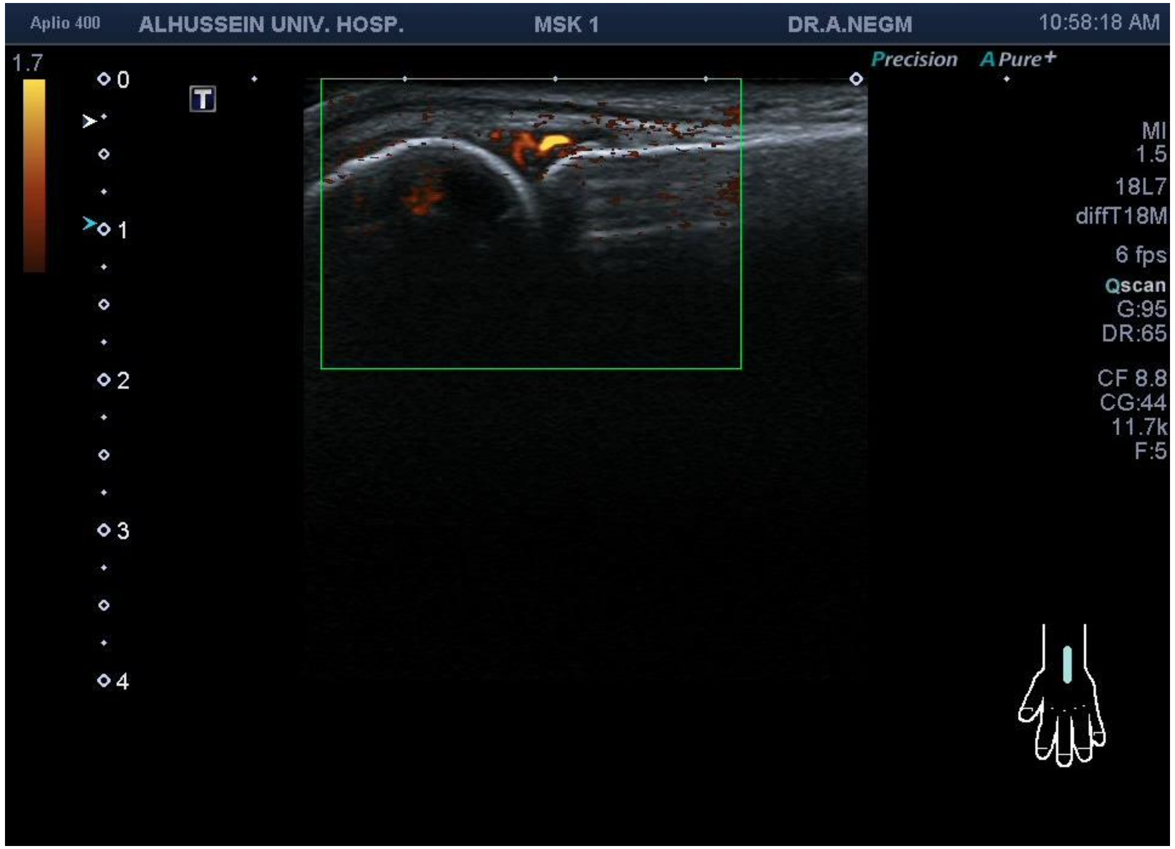
Dorsal TS of over extensor tendon (compressible effusion and synovial hypertrophy)

Suprapatellar TS over knee joint effusion

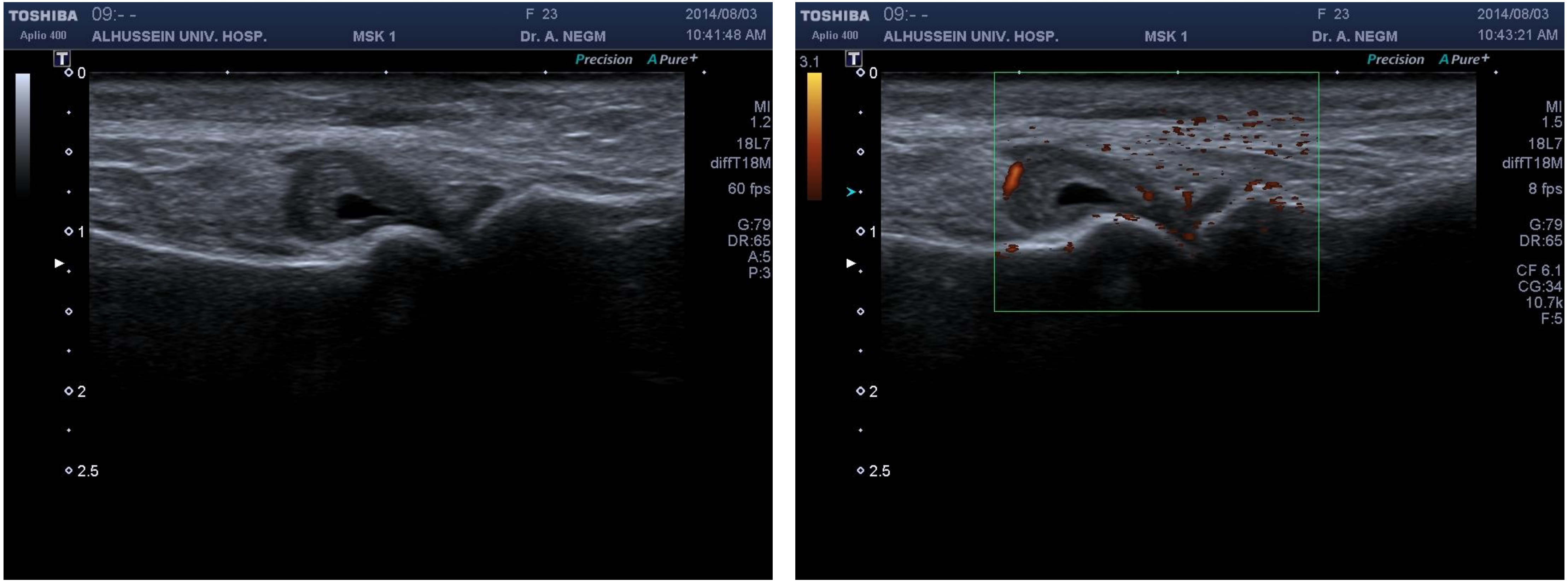




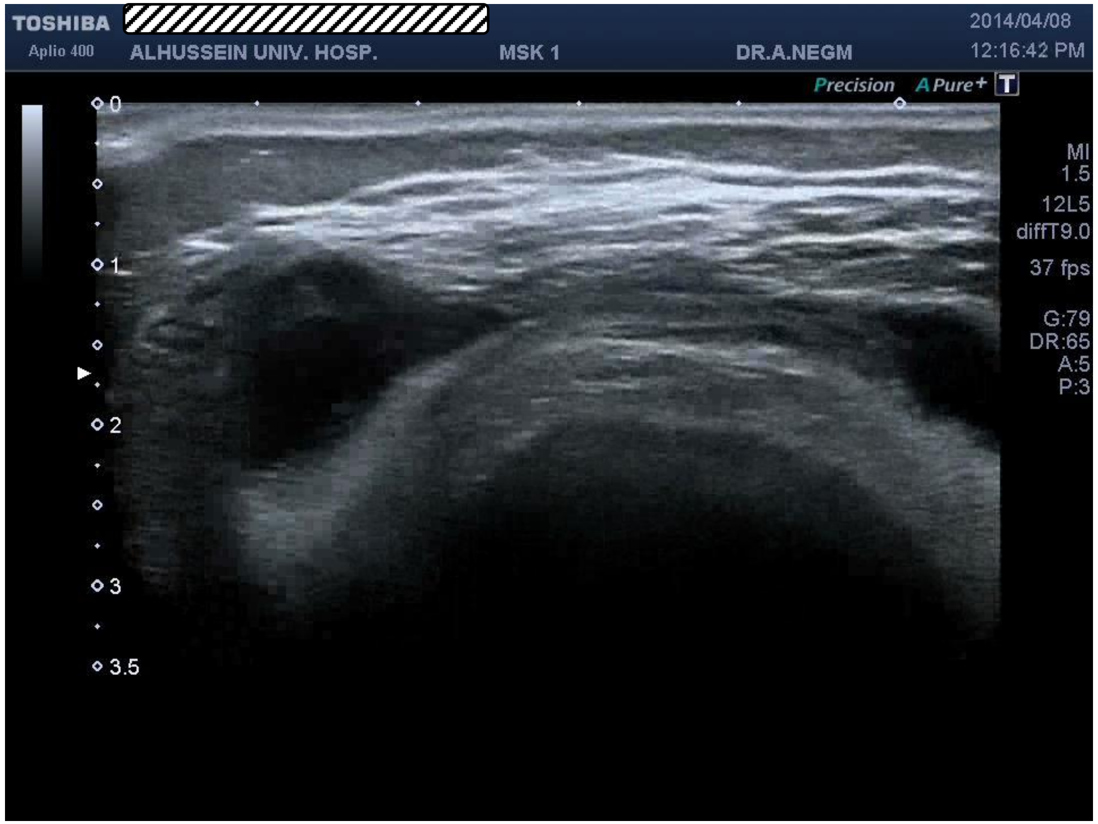
Video Left 3rd MCP longitudinal scan showing Synovitis by different Doppler modalities (Power- Color- Advanced Dynamic Flow)

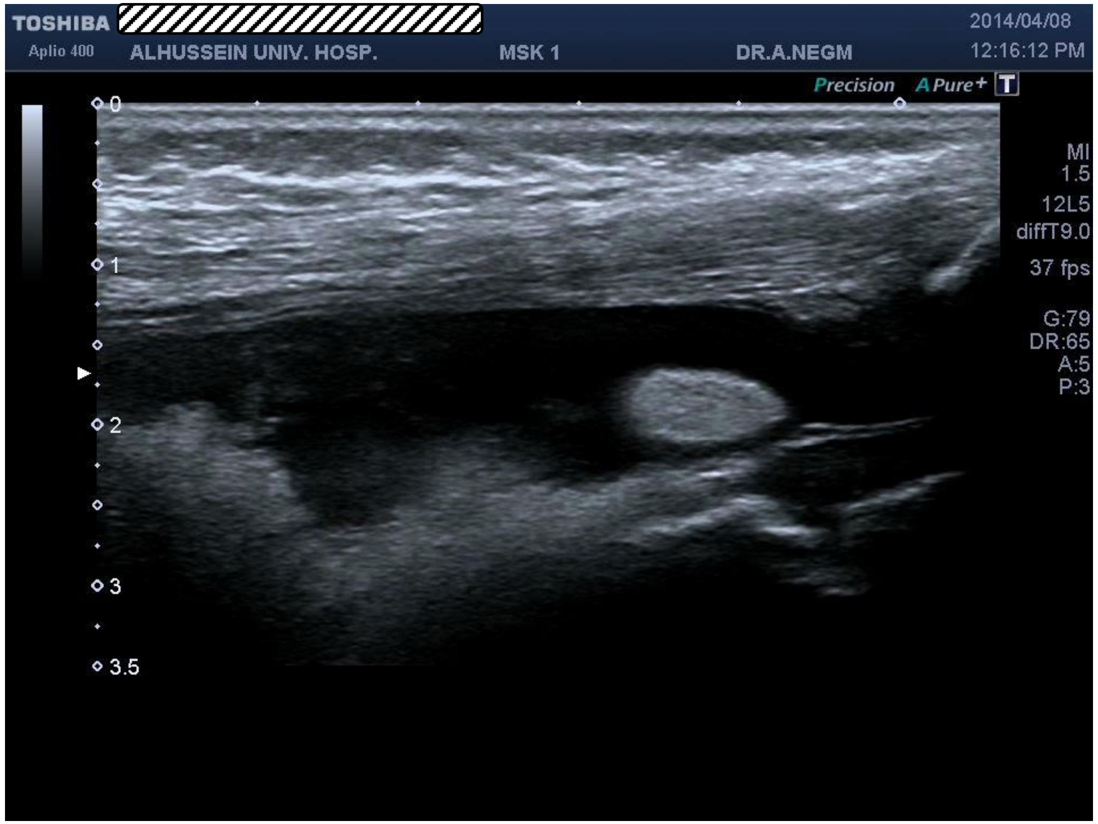


Dorsal LS MTP (effusion, synovial hypertrophy and positive Doppler signal)



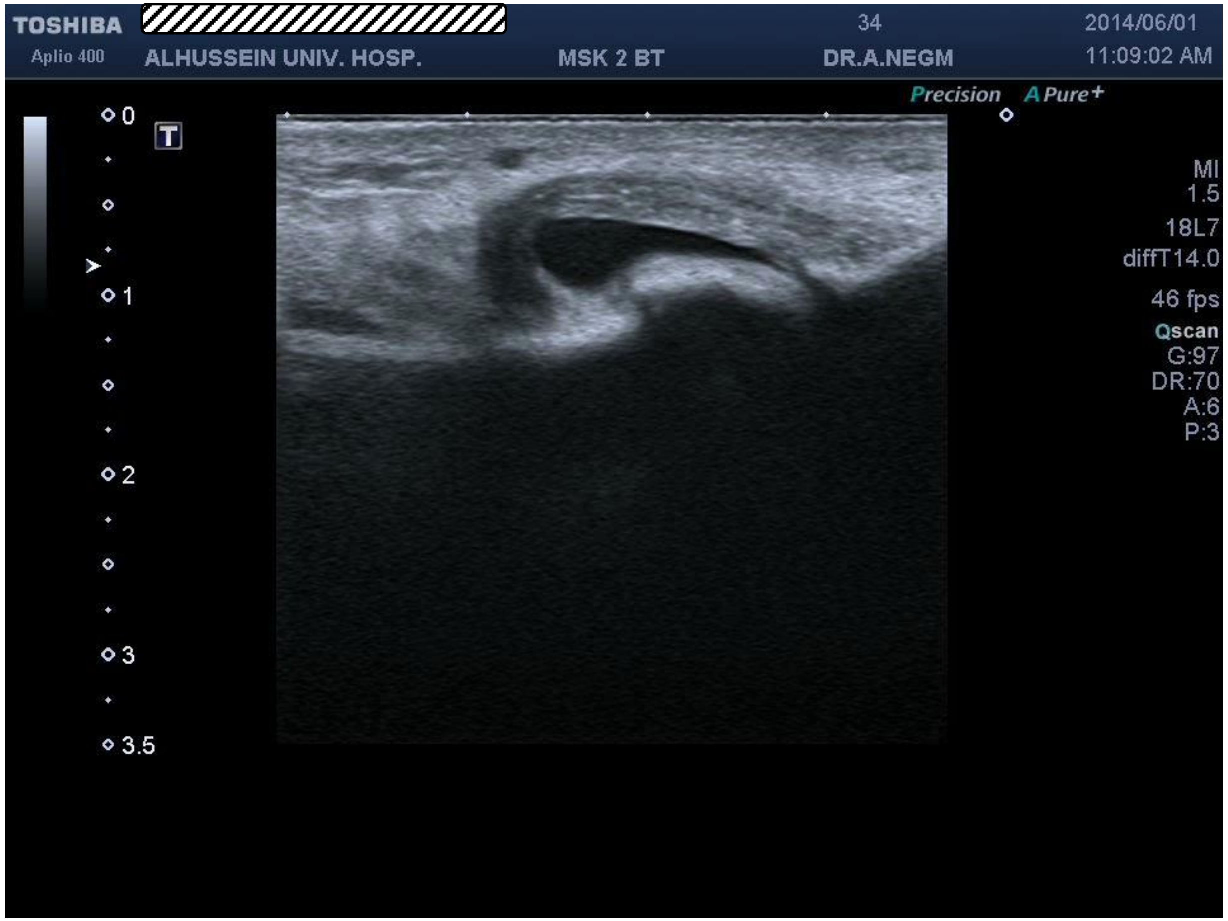
Video Longitudinal and transverse Dynamic examination of Knee suprapatellar recess (Effusion, Synovial hypertrophy)



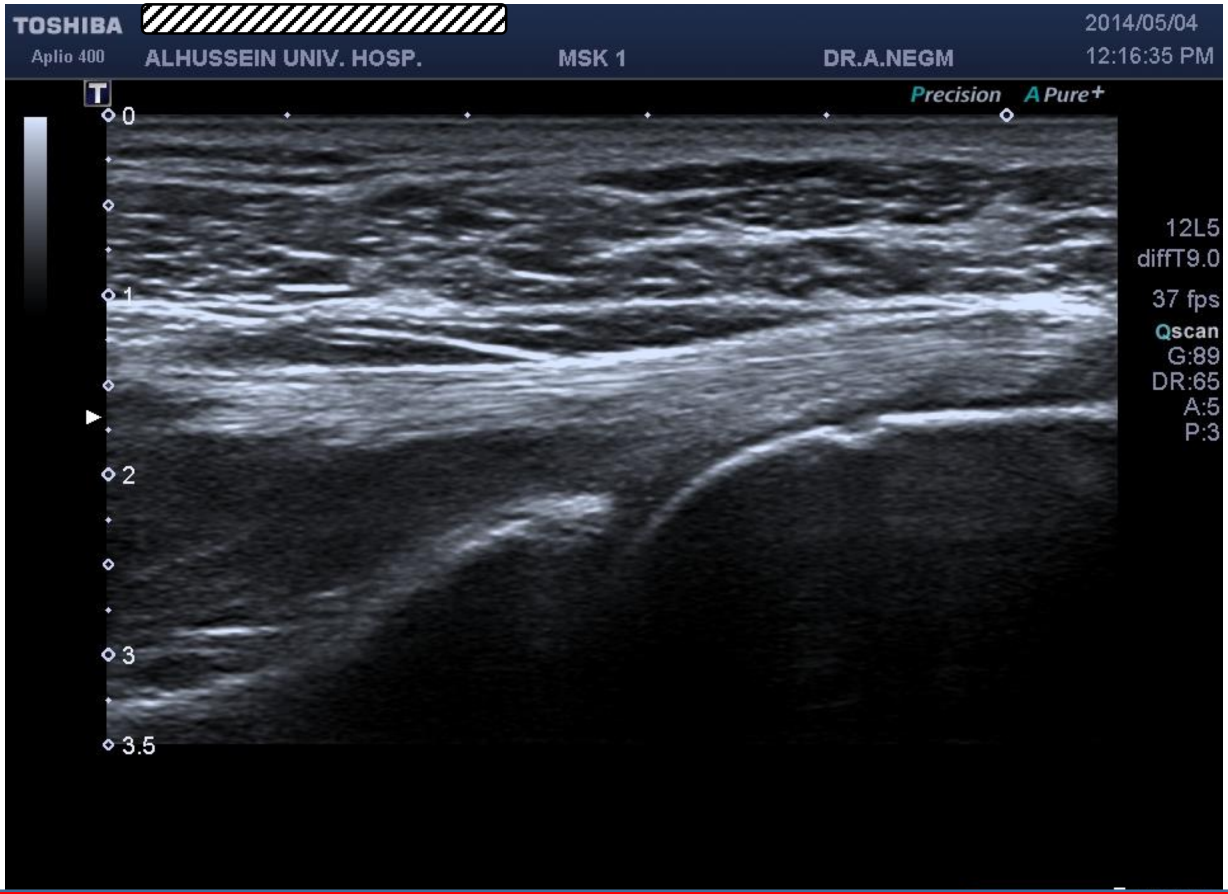


Dynamic Dorsal LS 1st MTP

effusion, synovial hypertrophy

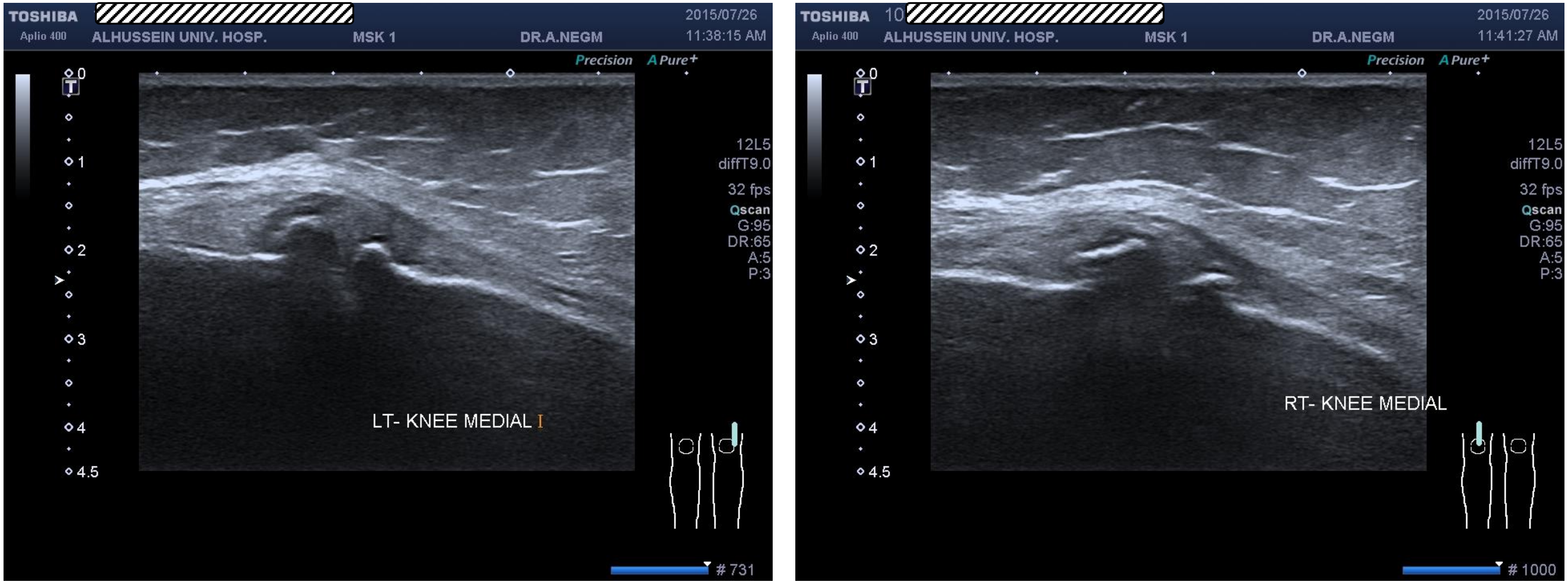


Posterior TS shoulder Glenohumeral joint

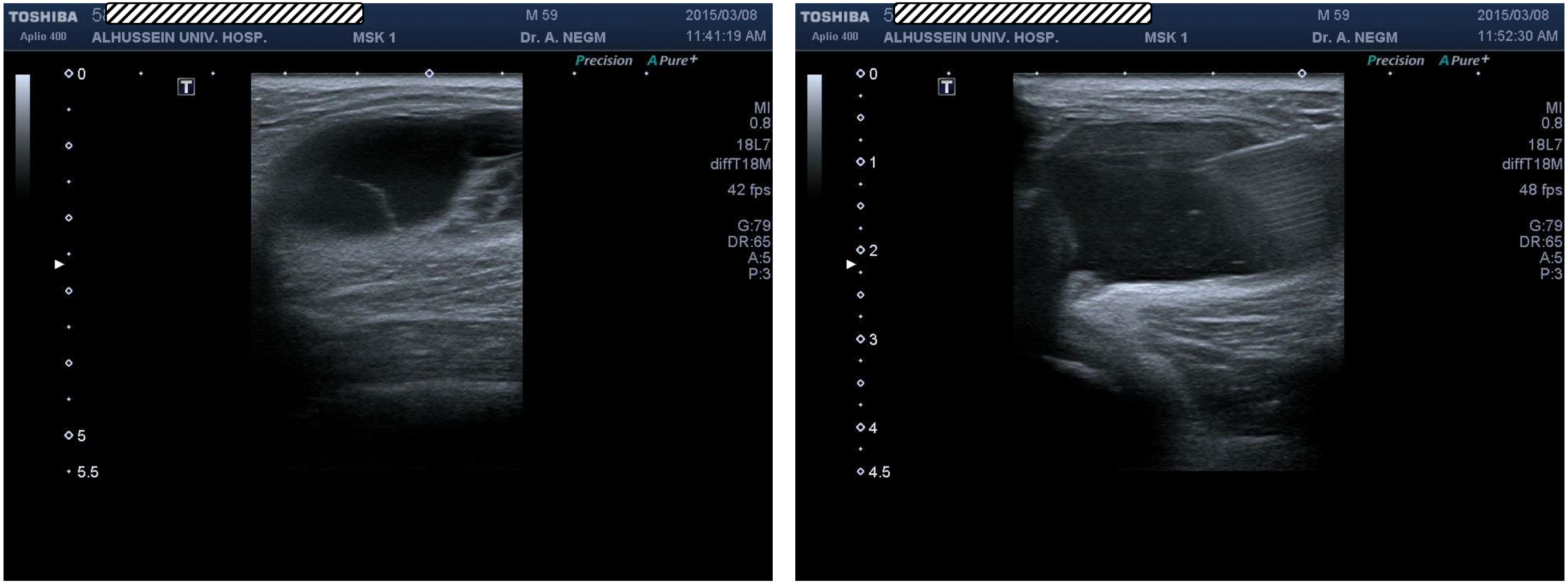


Cortical step down small Erosion (likely traumatic) in the posterior humeral head underneath the infraspinatus tendon

Osteophyte in Medial longitudinal scan of the knee with joint space narrowing and extruded medial meniscus

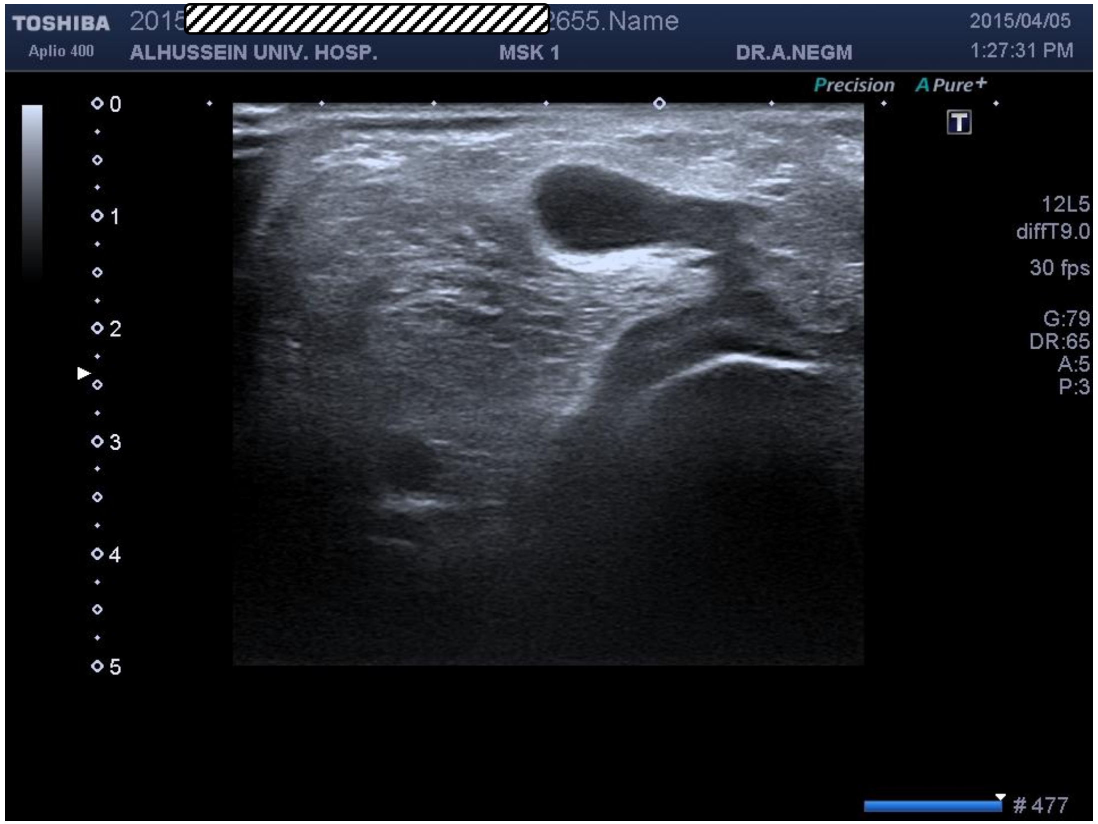


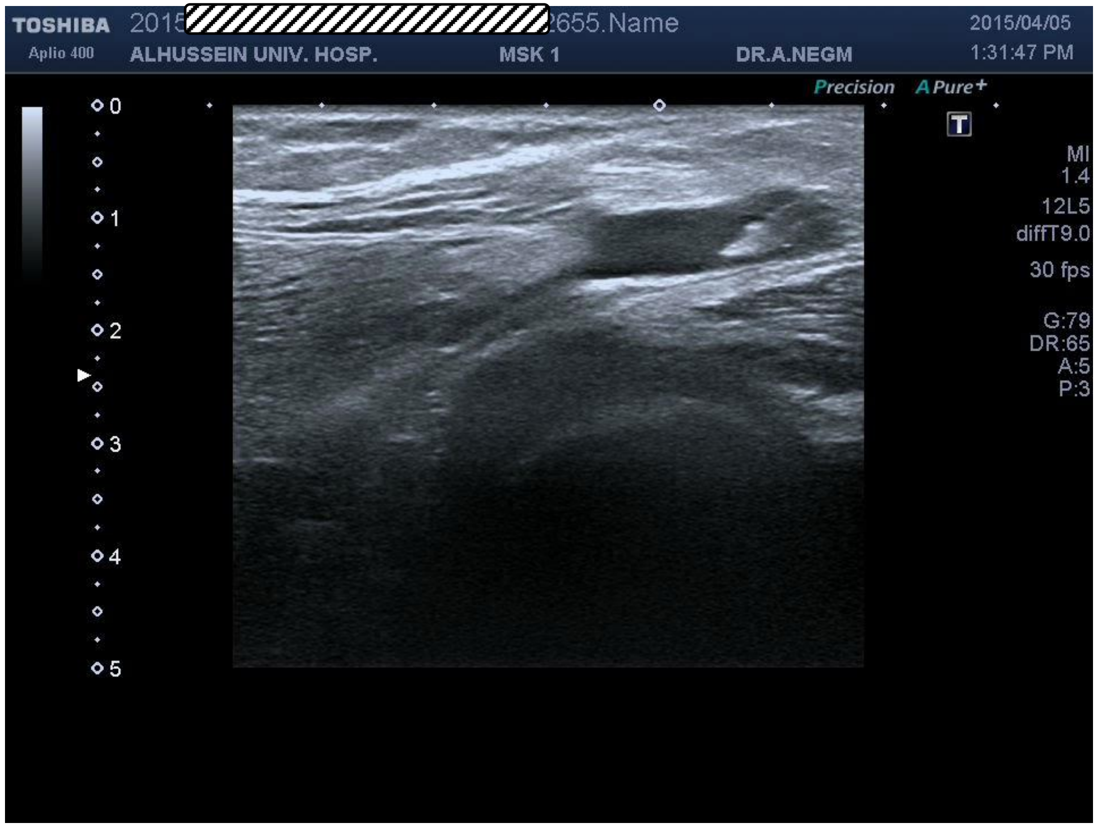
Video Posterior TS of knee (Baker cyst aspiration)



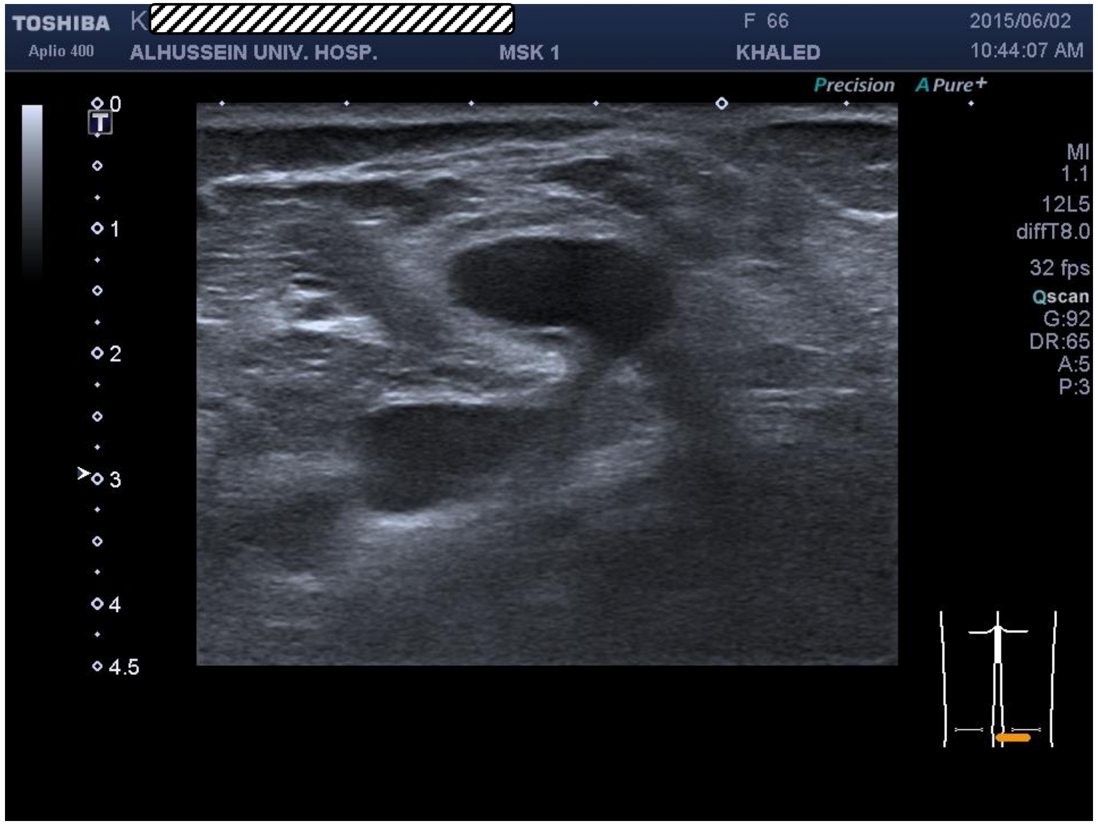
Displaceable anechoic fluid effusion with floating echoic deposits, the hypoechoic synovial lining is thickened and forms pedicles that float with probe compression. The right video demonstrate the needle aspiration

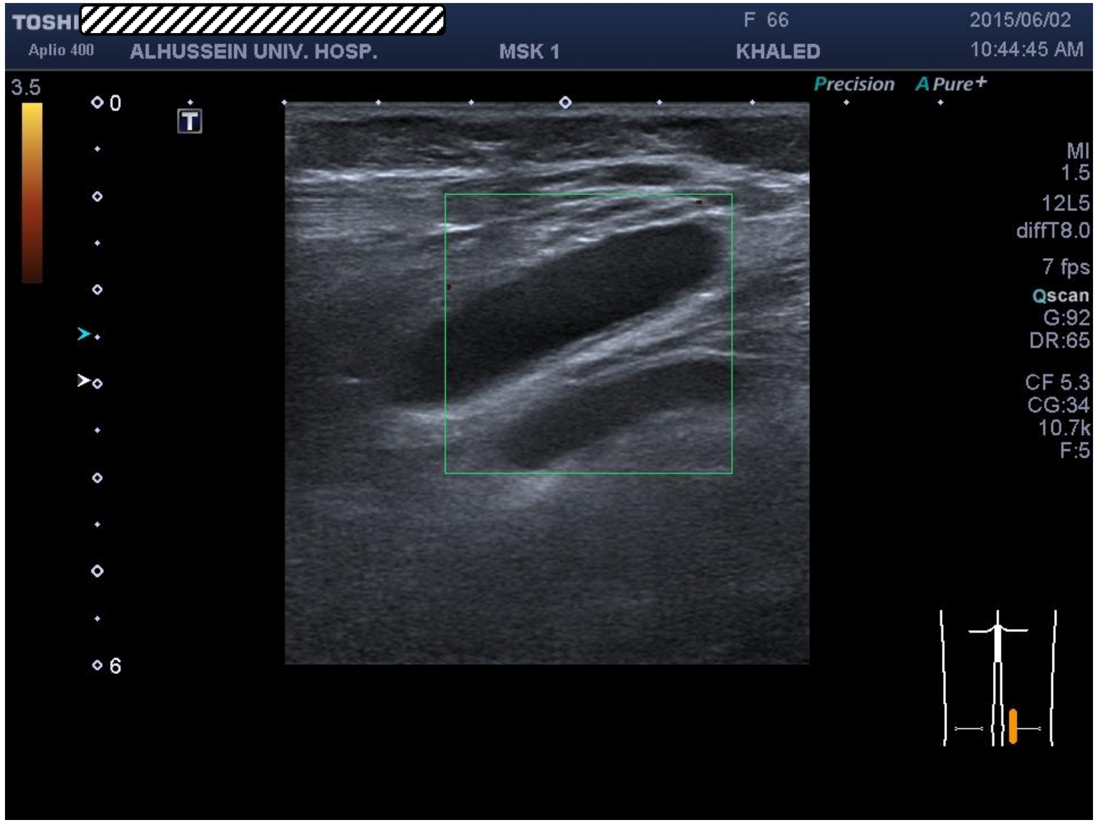
Video Posterior knee TS (Baker cyst – aspiration)





LS and TS Medial Posterior scan of the knee (Baker cyst)





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